Journal

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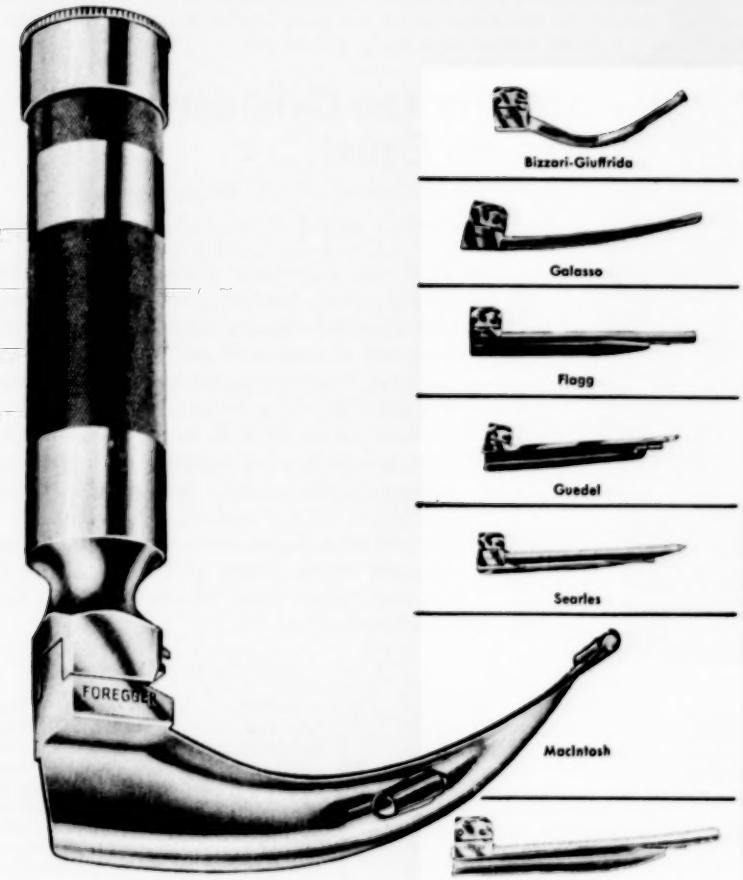

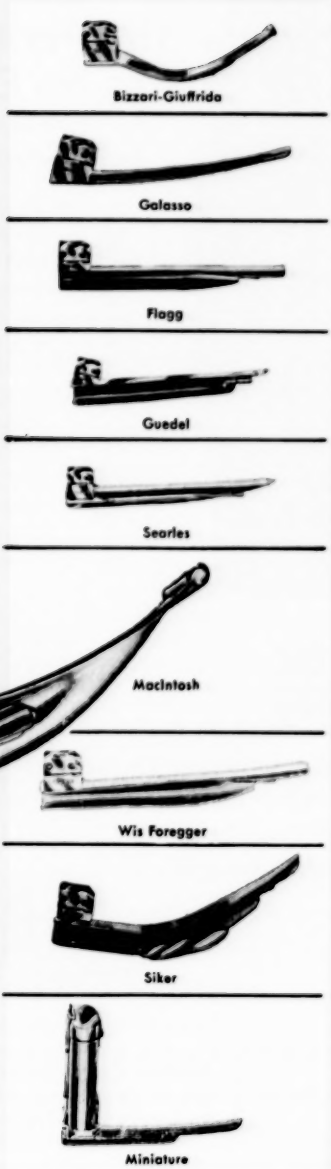

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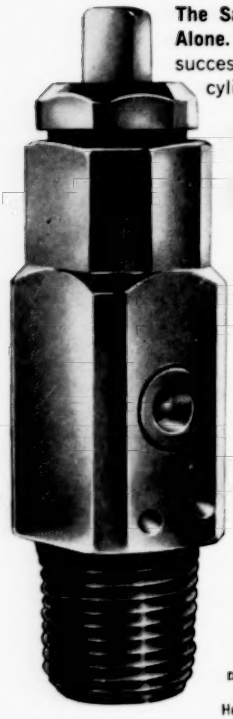

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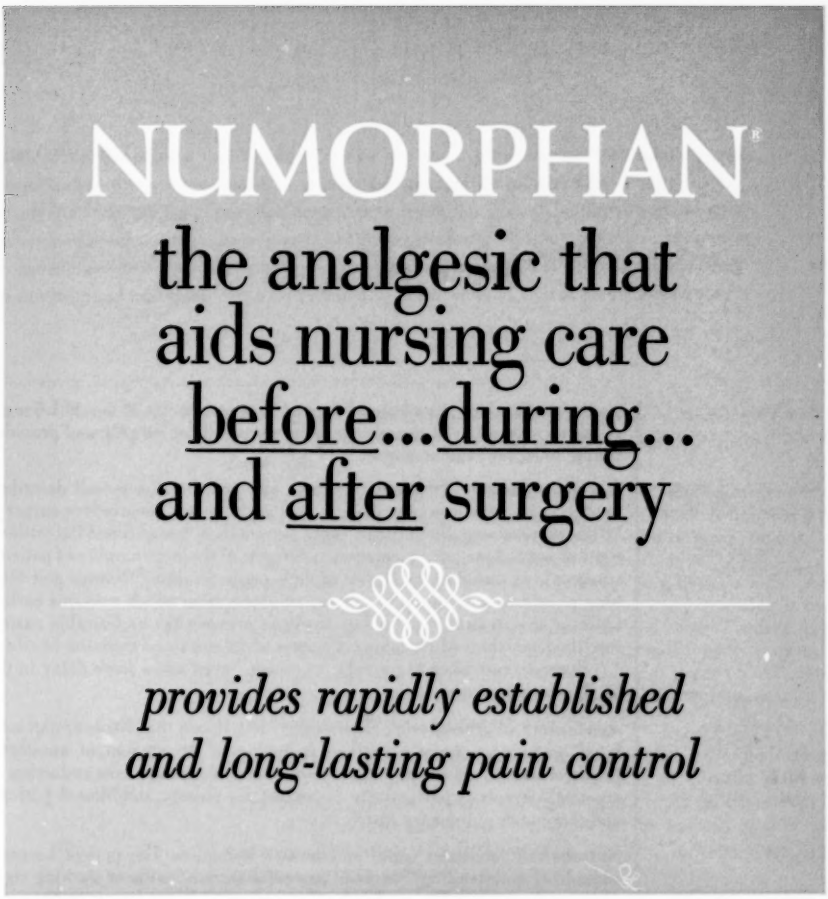

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minimal likelihood of nausea or vomiting

The characteristic "NUMORPHAN effect" in premedication is well described by Appleton,[1] who used the drug in 434 patients one hour before surgery: "Patients receiving Numorphan came to operation tranquilized but without signs of confusion or disorientation.... in spite of the large number of patients who received scopolamine as part of their premedication." Nausea and vomiting were not found to be problems, an observation which confirms earlier findings[3] that NUMORPHAN is less likely to provoke the undesirable gastrointestinal reactions of morphine. Because of its sustained duration of effect, NUMORPHAN continues to provide "coverage" even when some delay in the O. R. schedule occurs.

effective adjunct during surgery

meets the need for supplemental analgesia

As Adjunct to Anesthesia: Experience[1,2] has shown that NUMORPHAN as a basal analgesic permits a marked reduction in the amount of anesthetic required thereby offering increased *safety* and *economy*. This reduction in anesthetic agents is particularly important for elderly, debilitated patients and those with pulmonary insufficiency.

rapid, smooth induction

NUMORPHAN facilitates rapid and smooth induction. The patient becomes capable of withstanding "the most powerful stimuli" without showing signs of being disturbed.[2] The analgesic effectiveness of NUMORPHAN is described as superior to that of meperidine in providing *supplemental* analgesia; the blood pressure usually remains within normal physiologic bounds, in contrast to the circulatory depression (often verging on shock) reported after meperidine.[2]

cough reflex retained

seldom affects circulatory and autonomic homeostasis

In a series of operations on the head and neck, patients maintained their airway and spontaneous breathing in spite of the severity of the procedure and massive bandages.[2] The patient usually remains quiet yet retains the cough reflex. The action of NUMORPHAN during anesthesia is usually characterized by the preservation of circulatory and autonomic homeostasis.[4] Where

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SUMMARY: NUMORPHAN is a highly effective analgesic providing simple sedation and tranquilization that makes possible satisfactory preparation of patients of all ages for surgery. As an adjunct to anesthesia, NUMORPHAN facilitates smooth induction and reduces the amount of anesthetic agents required.[1,2] Postoperatively, NUMORPHAN-treated patients are usually well oriented and virtually free from pain or gastrointestinal side effects; they are not drugged into deep sleep and remain in full control of vital protective reflexes.[1-4]

prompt response to antagonists

indicated, as with inadvertent overdosage, intravenous nalorphine (Nalline®) or levallorphan (Lorfan®) is promptly effective in reversing respiratory depression.[5]

NUMORPHAN—satisfactory in the recovery room and special care unit

continuation of operative pain-free state

fewer injections required

In the Recovery Room: NUMORPHAN permits continuation of the pain-free state established during operation. The action of NUMORPHAN has proved "entirely satisfactory" in the "recovery room, special care unit, older patients and children..."[1] The patient who receives NUMORPHAN may be easily roused and is in control of his vital protective reflexes; thus, he can cough. In addition, his mental functions are not blurred, so that communication is readily possible. Other patients in the recovery room are rarely disturbed by the quiet NUMORPHAN patient. The pain relief extended by NUMORPHAN is usually so satisfactory in quality and duration that fewer repeat doses are required. Since NUMORPHAN does not commonly induce deep sleep, it often permits earlier discharge from the recovery room.

NUMORPHAN analgesia accompanied by sedation, not deep sleep

NUMORPHAN is primarily an *analgesic* not a *hypnotic;* therefore the absence of deep sleep should not be interpreted as lack of effective pain relief. Regarding this unique property of NUMORPHAN, Appleton[1] has stated: "It is most important that the entire nursing service be advised of this lack of soporific effect, especially if the nursing personnel is accustomed to using narcotics in hypnotic doses..."

NUMORPHAN should not be used to induce sleep

Postoperative Analgesia: When the patient is back in his room, NUMORPHAN keeps him mildly sedated and free from pain with a minimum of injections and untoward reactions. "It is inadvisable to attempt to achieve marked sedation characterized by sleep by increasing the recommended dosage."[1]

valuable for use in emergencies

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1. Appleton, J. C.: Anesth. & Analg. 39:505, Nov.-Dec., 1960. 2. Seigleman, M., and Wasmuth, C. E.: Cleveland Clin. Quart. 27:157, July, 1960. 3. Coblentz, A., and Bierman, H. R.: Fed. Proc. 14:327, Mar., 1955; New England J. Med. 255:694, Oct. 11, 1956. 4. Rondeau, Y.; Knaff, M., and Keeri-Szanto, M.: Union méd. Canada 90:48, Jan., 1961. 5. Adriani, J.: Postgrad. Med. 27:723, June, 1960.
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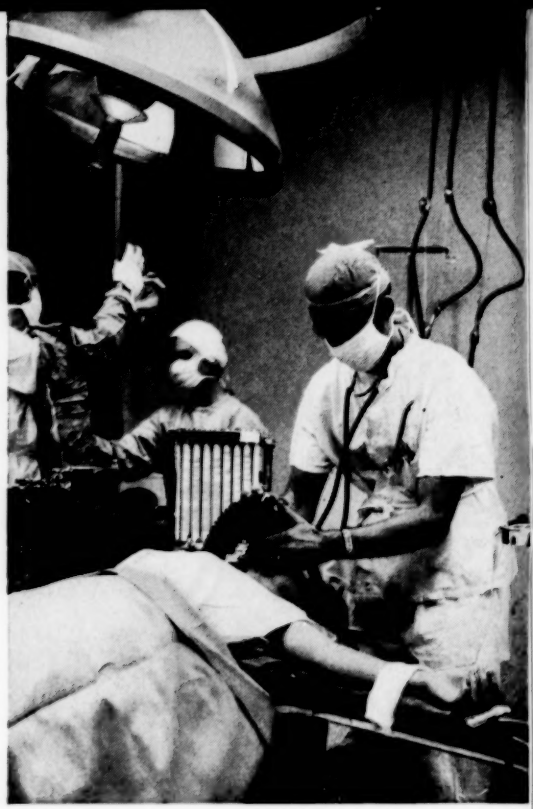

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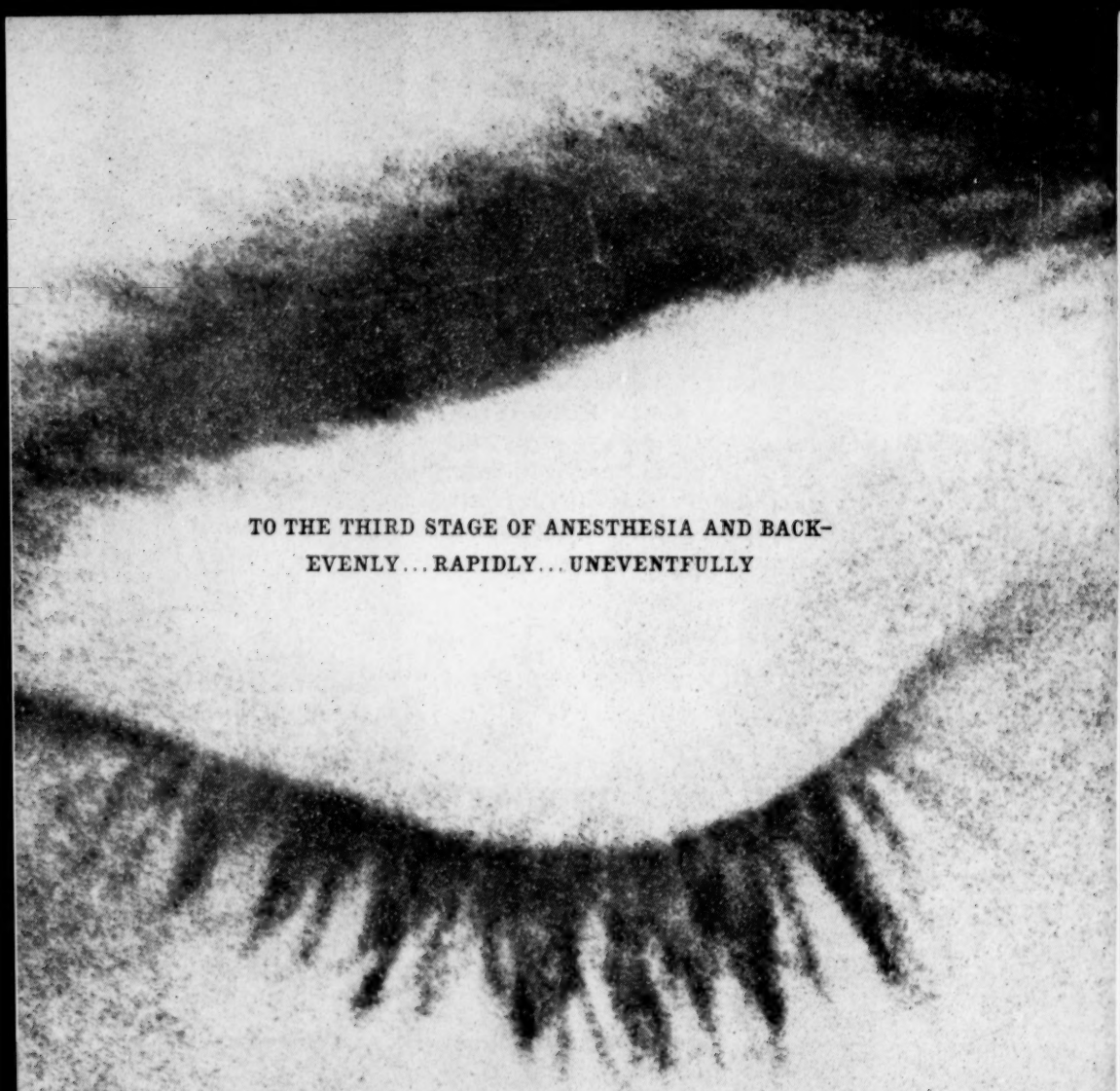

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Pre-anesthetic Preparation and Evaluation of the Patient with Heart Disease

D. LeRoy Crandell, M.D.*

Winston-Salem, North Carolina

The particular type of heart disease is less important than the effective functional capacity of the heart. A knowledge of what the heart can do both at rest and at exercise will give the best estimation of the patient's cardiac reserve and the ability to tolerate the stress of anesthesia and surgery. The cardiac reserve in acquired disease shows more progressive diminution than with congenital lesions. In acquired disease both the myocardium and the valves are usually involved. The myocardium in acquired heart disease is more susceptible to the depressant effects of anesthetic agents and to the production of arrhythmias.

How well the patient tolerates the stress of anesthesia and surgery depends on the pre-anesthetic preparation. Before the cardiac patient is subjected to anesthesia and surgery, the functional state of the heart must be restored to its optimal capacity in order to minimize the risk involved. There are many drugs at our disposal which may be used to improve the functional capacity of the heart. However, certain drugs used indiscriminately may produce impairment instead of improvement. Too frequently anesthetic difficulties are ascribed to the patient's inability to tolerate the specific anesthetic agent used. In general most patients tolerate anesthesia well provided that the patient is suitably prepared and the anesthesia properly managed.

In clinical practice, it is the cardiac reserve that must ultimately be considered by the anesthetist when deciding whether a patient with heart disease is suitable for an anesthetic and operation. The cardiac reserve is the capacity of the heart to perform its function of propelling enough blood to meet the extra demands of the body under unusual conditions of stress. The heart meets the demands for greater volumes of circulating blood by increasing its output. The heart increases its output by increasing heart rate and increasing diastolic filling and systolic emptying of the ventricles. Alterations in cardiac rate and rhythm, decreased coronary blood flow and myocardial contractile force will decrease cardiac reserve. In addition, obstruction to the outflow of blood by valvular stenosis or regurgitation or by recirculation through abnormal shunts (Patent Ductus Arteriosus) will diminish cardiac reserve. Patients having mitral or aortic valvular stenosis have a reduced and relatively fixed cardiac output.[1] They are unable to

* Associate Professor and Chairman, Department of Anesthesiology, Bowman Gray School of Medicine, Winston-Salem, North Carolina.

Presented at the annual meeting, American Association of Nurse Anesthetists, Atlantic City, September 28, 1961.

compensate as well for the myocardial depressant and peripheral vasodilating effects of anesthetic agents.

The heart shows a progressive diminution in myocardial reserve resulting from the degenerative changes of advancing age and the stress imposed by congenital lesions and hypertension. Arteriosclerotic changes of varying degrees are a constant accompaniment of advancing age. These arteriosclerotic changes affect both the myocardium and valves as well as the coronary circulation. Cardiac function in the elderly patient may show a diminished cardiac reserve even though symptoms are absent. The senile heart has a decreased ability to compensate for circulatory stress by increasing cardiac output through an increase in myocardial contractile force and heart rate. Anesthesia associated with its myocardial depression and peripheral vasodilatation may be sufficient to unmask an incipient myocardial decompensation.

MYOCARDIAL FUNCTION

Evidence of myocardial decompensation will be detected by signs of pulmonary congestion, increased venous pressure, peripheral edema, hepatic enlargement and dyspnea. It is extremely hazardous to administer anesthesia to a patient with myocardial decompensation. The patient should be treated adequately before surgery to achieve an optimal state of cardiac compensation. Digitalis still remains the most useful agent for improving myocardial function in cardiac decompensation. Digitalis not only improves the contractile strength of a failing myocardium but also the mechanical efficiency of the myocardium. Routine digitalization is not advocated because of age but only if the indications exist. The patient should be digitalized slowly if time permits. Rapid digitalization may produce digitalis toxicity with increased ventricular irritability. If the patient is already on a maintenance dose of digitalis, one should decide if digitalization is adequate. The patient may be adequately digitalized at rest but under-digitalized for increased stress. Diuretic therapy may also be indicated but should not be too drastic. Over-treatment with diuretics may produce electrolyte imbalance and renal insufficiency. A rising BUN is a sign of too enthusiastic diuretic therapy. Potassium depletion as a result of diuretic therapy will produce or enhance digitalis toxicity.

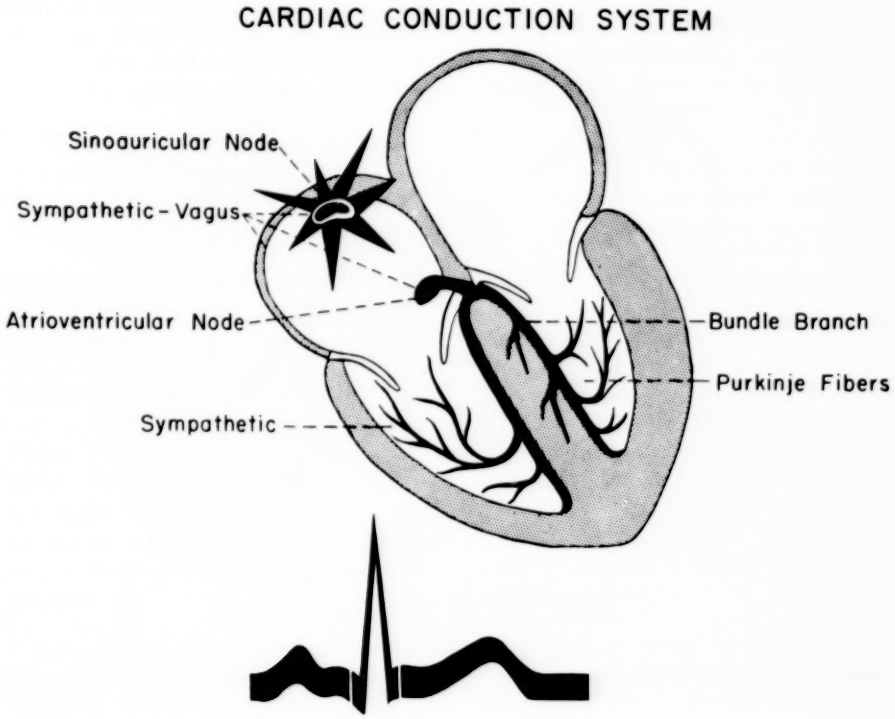
CORONARY BLOOD FLOW

The heart extracts fully 70% of the oxygen presented to it. Even on increased demand normal hearts extract only 70% oxygen and no more. Hence an increased oxygen demand is greatly dependent on increased coronary blood flow. Coronary blood flow is related to the perfusion pressure and the vessel resistance. The major proportion of coronary inflow takes place during the diastolic phase of the cardiac cycle. Any reduction in the duration of this phase may be harmful. This occurs when there is an increase in heart rate. A fall in the aortic pressure head which provides the driving force in the perfusion of the myocardium with oxygenated blood will decrease coronary blood flow. Atherosclerosis decreases coronary blood flow by narrowing the arterial lumina and increasing resistance to flow. An insufficient coronary blood flow associated with coronary artery disease is a common cause of sudden death in the operating room.

It is of vital importance that the patient with coronary artery disease have adequate sedation to produce cardiac tranquility as well as mental tranquility. The patient should not be subjected to anxiety producing situations just prior to the induction of anesthesia. If the patient complains of chest pain which lasts more than a few minutes just prior to anesthesia the operation should be postponed. The patient should not be sedated with narcotics. Narcotics may mask the pain which is a warning signal that coronary insufficiency exists. In addition, the narcotic drugs may initiate coronary insufficiency by producing circulatory and respiratory depression. A history of angina with increasing severity and with progressively less exertion is a warning of impending coronary occlusion and operation should be avoided, if possible. If a myocardial infarction has occurred within a three month period prior to surgery, an operation should only be done as an emergency procedure. This is the period of time generally accepted as being necessary for satisfactory healing. During the time the patient is being prepared for the induction of anesthesia, oxygen should be administered.

CONDUCTION SYSTEM

The conduction system begins as a specialized node of fibers, the sinoatrial node. The stimulus for the heart beat normally arises in the sinoatrial node, the heart's pacemaker. The impulse then spreads through the atrial musculature to the atrioventricular node. It then passes down the atrioventricular bundle and its

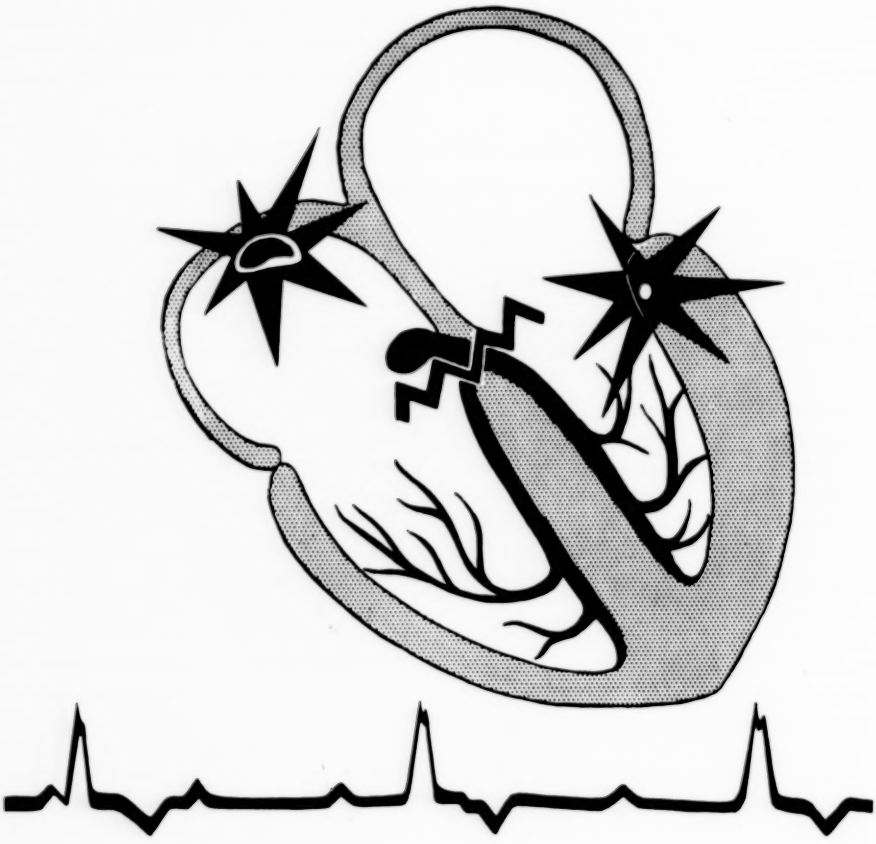


branches, the Purkinje system and finally reaches the ventricular myocardium.

Adequate atropinization is essential to maintain the dominance of the sino-atrial node. The sino-atrial node normally controls cardiac rhythm because it possesses the greatest degree of inherent rhythmicity. Increased vagal tone will depress the irritability of the sinus pacemaker of the heart and may allow pacemaker control to be relegated to more irritable foci located lower down in the conducting pathway. Thus the cardiac rhythm may become atrioventricular nodal or even ventricular in origin.

When an impulse arising in the atrium is not transmitted at the normal rate to the ventricle by the atrioventricular node or bundle there is heart block. Heart block is usually of serious import. A well established bundle branch block does not appear to greatly enhance the risk of surgery. However, the patient with complete atrioventricular block presents an extremely grave risk for anesthesia and surgery. These patients are prone to develop Stokes-Adams at-

COMPLETE ATRIOVENTRICULAR BLOCK



tacks and sudden cardiac arrest during surgery. Prophylactic treatment before surgery is essential. This consists of atropine sulfate 1 mgm. intramuscularly thirty minutes pre-operatively and 0.5 mgm. intravenously every two hours during surgery. In addition a sympathomimetic amine such as isoproterenol should be given in doses of 15 mgm. sublingually two hours pre-operatively and by intravenous drip in a dilution of 4 mgm. per liter during surgery. In general, anoxia, acidosis and anesthetics depress the conduction system as well as the myocardium. The sympathomimetic effect of ether makes it a valuable agent for anesthesia in this situation. The cardiac activity should be monitored continuously and a cardiac pacemaker-defibrillator unit should be in readiness. In addition should cardiac arrest occur, molar sodium lactate intravenously (20-80 cc.) has been shown to be effective in restoring ventricular beat without causing ectopic rhythms.

The elderly heart has an increased tendency to develop abnormal rhythms. Certain arrhythmias appear more significant to the anesthesiologist than others. The chronic atrial fibrillator whose ventricular rate is well controlled with a digitalis glycoside usually does well during anesthesia. However, extreme caution should be taken with the patient having a history of episodes of acute atrial fibrillation. The onset of acute atrial fibrillation during surgery is a warning of impending cardiac decompensation and the operative procedure should be terminated as soon as possible.

Frequent premature atrial or ventricular contractions may be the forewarning of incipient cardiac decompensation or the development of arrhythmias of a more serious nature.

An unexplained tachycardia in the elderly patient is a cause of great concern. Apprehension is not the most common cause of tachycardia in the pre-anesthetic period. The operation should be delayed until the cause is determined and the appropriate therapy administered. It is usually found to be due to a previously unsuspected organic heart disease or hypovolemia. The danger of a tachycardia lies in the shortening of the diastolic phase of the cardiac cycle which may precipitate coronary insufficiency or myocardial decompensation.

With advancing age, the heart becomes less sensitive to the effects of atropine and more sensitive to carotid sinus stimulation. This increased sensitivity of the carotid sinus may be an important cause of sudden cardiovascular collapse during surgery. The sensitivity is enhanced by inflammation in the anterior triangle of the neck from infection or radiation therapy. In addition drugs such as digitalis, morphine, thiopental, cyclopropane and antihypertensive agents may increase the sensitivity of the carotid sinus. Hypoventilation associated with hypoxia and hypercarbia also enhances the sensitivity of the carotid sinus. Stimulation of the carotid sinus may occur during surgery from extension of the neck or from manipulation during a radical neck dissection. Marked hypotension associated with bradycardia will result and appropriate doses of intravenous atropine sulfate should be administered.[2]

The risk involved in administering anesthesia to the patient with aortic valvular disease is particularly grave.

CAROTID SINUS REFLEX (DEPRESSOR)

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1. Arteriosclerosis
2. Inflammation anterior triangle of neck
3. Digitalization
4. Morphine
5. Thiopental Sodium
6. Cyclopropane
7. Halothane
8. Rauwolfia Derivatives
9. Hypoxia
10. Hypercarbia (Respiratory Acidosis)

Inhibition

1. Atropine Sulfate

These patients are subject to sudden death from coronary occlusion and ventricular fibrillation.

PRE-ANESTHETIC DRUG THERAPY

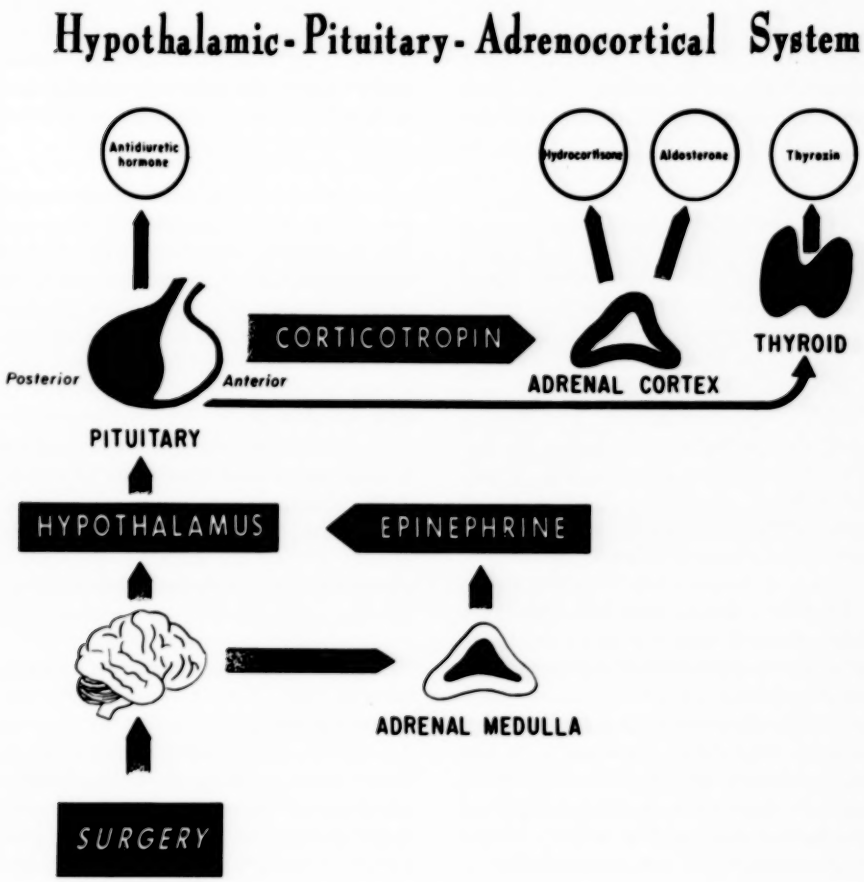
In recent years a new and insidious hazard has evolved in patients undergoing anesthesia and surgery. This is the multitude of drugs that patients are receiving for a variety of reasons. Thus the anesthetist is faced with the problem of maintaining circulatory homeostasis in the patient who has been on long term therapy with cortisone, antihypertensive preparations, phenothiazine derivatives and other less potent tranquilizers. When the patient is subjected to the stress of anesthesia and surgery, these drugs often adversely affect the circulation.

With the present widespread use of cortisone, inevitably some patients will face the stress of anesthesia and surgery with suppressed adrenocortical function. The suppressive effects on adrenocortical function may last for many months. Adrenocortical insufficiency subjects the patient to severe hypotension, respiratory depression and prolonged recovery from anesthesia. There is some good experimental evidence to support the view that in adrenocortical insufficiency a diminution of vascular contractile responsiveness occurs to circulating catechol amines. It has been postulated that the loss of sodium and the ensuing distortion of the intracellular-extracellular electrolyte gradient of the vascular muscle cells lower the blood pressure through interference with the normal vasoconstrictive efficiency of intrinsic norepinephrine and epinephrine.[3, 4, 5]

It is, therefore, recommended that any patient who has had therapeutic doses of cortisone for more than a week within the six month period preceding surgery should have supplementary cortisone the day before, during and in the immediate postoperative period in order to avoid the occurrence of acute adrenocortical insufficiency. The dose of cortisone administered should be 100 mgm. the night before surgery. On the operative day, the dose should be equivalent to that produced by maximal stimulation of the adrenal cortex which is approximately 10 mgm. per

hour. This can be administered in a 100 mgm. dose intramuscularly two hours pre-operatively followed by 50 mgm. intramuscularly every six hours. An alternate method would be to give 100 mgm. per liter of 5% dextrose in water by intravenous drip every eight hours. Starting on the first post-operative day the total daily dose of cortisone may be reduced in 50 mgm. increments per day.

Severe hypotension associated with bradycardia may occur in patients who have received rauwolfia derivatives such as reserpine for the treatment of hypertension.[6] This untoward effect is related to depletion of the intrinsic catechol amines in the myocardium, vascular wall and adrenal medulla.[7] Under normal conditions, stores of epinephrine and norepinephrine in the myocardium and vascular wall are released in small amounts and are necessary as humoral agents for the regulation of the cardiac pacemaker and to maintain a normal state of myocardial and peripherovascular contractility. Correction of the hypotension might logically be obtained by supplying the necessary amount of the missing catechol amine, norepinephrine or the use



of methoxamine and phenylephrine which act directly on the vascular wall to produce vasoconstriction. The group of sympathomimetic amines, such as ephedrine, which lose their effect following reserpine therapy normally act by releasing epinephrine or norepinephrine from the store in the artery wall. The rauwolfia derivatives appear to exert a pharmacological effect for approximately two weeks after therapy has been discontinued. To avoid any undue operative risk, the drug should be discontinued two weeks prior to elective surgery.

Guanethidine (Ismelin), a recently introduced antihypertensive agent, acts by inhibiting the release of norepinephrine from the postganglionic sympathetic nerve endings. The drug has a prolonged effect and should be discontinued seven days prior to anesthesia.

The antihypertensive agents such as the rauwolfia alkaloids and guanethidine produce a state where there is suppression of sympathetic activity with a concomitant relative increase in parasympathetic activity. Since vagal stimulation inhibits atrial contractility and conduction, and diminished sympathetic stimulation of the heart reduces the contractility of the entire heart, the added effect of direct myocardial depression by anesthetic agents may prove deleterious.

In 1951, Fisher and his associates demonstrated that diethyl ether acts as a direct myocardial depressant in the heart-lung preparations of dogs. In 1953, Brewster and Issacs discovered that ether anesthesia in the dog produced myocardial stimulation with an increased cardiac output which was due to the reflex release of norepinephrine and epinephrine.

Thus the safety of the action of ether upon the myocardium is determined by the quantitative reflex release of epinephrine and norepinephrine from the adrenal medulla and sympathetic nerve endings, which by virtue of their positive inotropic effect upon the myocardium antagonize the direct myocardial depression or negative inotropic effect of diethyl ether.

The clinical significance of this myocardial effect is that critical myocardial depression associated with profound hypotension may result from the direct depressant effect of diethyl ether upon the myocardium of a patient in whom the reflex release of epinephrine and norepinephrine from the adrenal medulla and sympathetic nerve endings is reduced or abolished.

In the presence of suppression of the reflex sympatho-adrenal response the vagotonic and direct myocardial depressant action of cyclopropane becomes manifested. Halothane by virtue of its effect to suppress sympathetic activity and enhance vagal tone would produce an additive effect of that produced by the antihypertensive agents. Anesthesia produced by cyclopropane and halothane would be particularly dangerous in this situation. Then, too, these anesthetic agents should be avoided because a norepinephrine drip may be required for the management of hypotension.

The hazards induced by chlorpromazine and other phenothiazine derivatives are their ability to depress or abolish reflex circulatory control. Prior therapy with these autonomic suppressants may be associated with hypotension, tachycardia, and prolonged recovery in the anesthetized

patient. The phenothiazines can initiate an extrapyramidal syndrome. Coma in the tranquilized diabetic may be more precipitous and more prolonged.

The principal danger of chlorothiazide is serum potassium depletion and sodium depletion in the peripheral vascular wall. The hypokalemia will enhance the toxic effects of digitalis. The depletion of the sodium in the vascular wall will reduce vascular reactivity to circulating catechol amines and other vasopressors.[8] Chlorothiazide will also potentiate the hypotensive effect of preganglionic blockade by spinal or epidural anesthesia and the ganglionic blockade of d-tubocurarine. Succinylcholine would be the best choice for muscular relaxation.

Digitalis, an important drug in preparing many cardiac patients for surgery, can be exceedingly dangerous and toxic if overdosage occurs. Rapid digitalization just prior to surgery can often cause digitalis toxicity, especially if there are uncorrected electrolyte imbalances with low blood potassium levels.

Curare should be used with caution in the patient on quinidine therapy. Quinidine has been shown to have a curariform action on neuromuscular transmission. In addition quinidine also interferes with the anticurare effect of neostigmine.

The elderly patient is much more sensitive to sedative drugs and narcotics. There is no doubt that deaths have occurred in the operating room in the older patient as a result of marked circulatory and respiratory depression from narcotics such as morphine or meperidine given preoperatively.

BLOOD VOLUME

An adequate blood volume should be established before anesthesia and surgery. It may be generally stated that no patient with a hemoglobin level below 10 gm. per 100 ml. or hematocrit below 35 per cent should have an elective operation without correction of the anemia. It should be emphasized that the debilitated patient may have normal hemoglobin and hematocrit levels and still have a markedly reduced blood volume. Hypovolemia is frequently present in the elderly, chronically ill patient and in the patient with malignancy or ulceration of the gastrointestinal tract. Anesthesia with its associated peripheral vasodilatation may unmask a chronic hypovolemia. When there is a decreased blood volume, the loss of even small amounts of blood is poorly tolerated and the patient tends to go into shock more readily. Once hemorrhagic shock has developed, the response to blood replacement is not always prompt. It takes less blood to prevent hemorrhagic shock than it does to treat it. The patient with hypovolemia may not be able to compensate for changes in body position or for the central nervous system depression required for anesthesia. The result may be profound hypotension from what appears to be a minimal cause.

Attempt should be made to correct the deficit in blood volume before the induction of anesthesia in order to avoid the consequences of shock. The patient should not undergo transfusion as a matter of expediency. Proper evaluation to determine the cause of the anemia or the reduced blood volume and the institution of appropriate therapy to avoid the inherent risk of a transfusion reaction is preferable except in an emergency.

Usually iron deficiency anemias are more appropriately corrected with iron therapy. There are really few emergency situations during which time cannot be taken to institute measures to restore an adequate volume of circulating blood. With the use of whole blood, plasma dispersal is essential to raise the hematocrit. Adequate time is necessary for plasma dispersal by the patients own renal and metabolic mechanisms. Twenty-four hours without transfusions should be allowed for equilibration prior to anesthesia. The elderly patient with heart, liver and renal disease requires more time for plasma dispersal. The use of packed red cells will obviate the necessity for plasma dispersal. This is important in emergency situations and in patients where the plasma dispersal mechanism is impaired and where the danger of producing hypervolemia exists. Overenthusiastic pre-operative transfusion of whole blood immediately prior to surgery may subject the cardiac patient to hypervolemia with subsequent cardiac decompensation and pulmonary edema.

SUMMARY

Careful attention must be given to the pre-anesthetic evaluation and preparation of the cardiac patient. The detrimental aspects of inadequate preparation are particularly impressive in this group. There are few emergency situations that occur in which time cannot be taken to institute measures which will improve the patient's chances for survival. In general most patients with heart disease will tolerate anesthesia well, provided the patient is suitably prepared and the anesthesia properly managed.

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Evaluation of the Patient with Renal Disease for Anesthesia

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There is probably no phase of anesthesia in which the question of evaluation of the pre-surgical patient assumes greater importance than in the patient with renal disease. As one searches the literature he finds that much is written on the patient with pulmonary disease and his ability, or inability, to withstand anesthesia and surgery. Even greater amounts of knowledge are dispensed in the journals and by the American Heart Association on the cardiac patient. The patient with kidney disease, however, is rather sadly neglected by both the journals and the various organizations.

Since 1948, I have practiced in hospitals in which the Urology Services have been very active and staffed by physicians who have proven to be rather outstanding in their specialty. Patients are referred to them with either suspected or proven kidney disease. These patients receive thoughtful and skilled pre-surgical evaluation. So it is not too great a problem for us to adequately understand the prime physiological defects in this group. Most of our patients are not so blessed. It has been my experience that many of the average surgical patients with hernias, cholecystectomies, gastrectomies, pneumonectomies, craniotomies, cataracts, and the like, have various degrees of unsuspected renal disease, which is more often than not touched upon only superficially by the attending surgeon. It is in this large and important group that our understanding and vigilance is most often rewarded. The exact general and renal status of these patients must be determined, and if this requires pre-operative treatment it should be carried out.

Patients with renal disease come in two sizes, small and large. Our ability to administer safe anesthesia must be equal in each group. It must be understood, however, that the margin of safety varies in direct proportion to the size of the patient. We should never lose sight of the fact that no age group is exempt from kidney disease. The diagnosis of kidney disease, and a true evaluation of this patient, is reached by coordinating the history, the general examination, the laboratory tests, and, when necessary, by x-ray and cystoscopic examination. I have always thought that it is essential to visit the patient and form one's own impression first hand. So often we take a short cut by way of the chart rack and are misled by the impression of some well-meaning, yet unskilled, intern.

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The evaluation of the patient with renal disease begins with the first visit. So often this is our only direct pre-surgical contact with the patient. It is at this time that we must not only very quickly begin to develop impressions of the patient, but permit the patient to form a favorable impression of us. Generally speaking, it is not the surgery per se that the patients fear, but the anesthetic which renders them unable to control their various faculties. This psychological boost is often as important to the patient as the physiological and anatomical impression which we receive from them is to us. Our history of past and present illness must be pursued in an orderly and skillful, yet tactful, manner. There is no doubt that the observations at the bedside are the basis of medicine. Our first impression is obtained through visual inspection of the patient. Does he appear to be critically ill? Is he in contact with his surroundings? Does he show signs of marked weight loss? Does he have signs of edema or dehydration? Is he dyspneic? Is he ambulatory? Does he appear to be anemic? The answers to these and other routine observations are noted almost without thought. The direct questioning of the patient varies, depending upon the age and the condition of the patient.

The function of the kidney may be vitally affected in a variety of disease states. Many of these are not primarily renal in origin. Such conditions as severe burns, crush syndrome, infection, shock, leukemia, diabetes, hypertension, and arteriosclerosis have important acute and chronic renal manifestations. The interrogation of the patient must be so varied as to encompass this wide variety of conditions. The importance of this phase of our pre-anesthetic evaluation should not be minimized. Just the other day I visited a patient who was to have a repeat Cesarean Section. While interrogating her I discovered that the previous section in 1959 was performed after she had developed "convulsions". A phone call to the obstetrician revealed that in 1959, at the age of 36, she had developed eclampsia and, in the interest of the child, a section had been performed. It then developed that she had progressive proteinuria during the past six weeks. Further kidney studies were most certainly in order before a safe anesthetic could be administered.

This is the sort of thing that develops quite frequently in our anesthesia practice. It is frequently necessary to refer to the patient's medical doctor, or the child's pediatrician, for vital information. Without question these men have a very profound understanding of the patient's medical life. So often we accept as gospel information received from our surgical colleague without realizing that he has known the patient for only a very short time. I have discovered that the patient's medical doctor or pediatrician is more often than not flattered by our call and willing to discuss at great length the patient's medical and urological background. We stand on a common ground with the medical man. Very often he, too, is called upon to aid in the post-surgical care of the patient and it goes without saying that our pre-operative vigilance and skillfully administered anesthesia decrease his post-surgical problems.

Before entering into a discussion of the various tests that are necessary to properly evaluate the patient with

renal disease, I feel that it is important to foster a short review of the basic anatomy and physiology of the kidney. The kidneys are paired, bean-shaped organs averaging, in the adult, 10.5 cm. in length, 6 cm. in width, and 3 cm. in thickness. They are situated in the posterior part of the abdominal cavity, behind the peritoneum. Their concave medial borders face toward the vertebral column. In the adult, the kidneys lie about one inch from the midline at the level of the last thoracic and the first two or three lumbar vertebrae. During inspiration the kidneys descend about an inch. In children, the kidneys lie lower than in the adult. The kidneys in the newborn are about three times as large in proportion to the body weight as in the adult.

The kidney is supported, and held in position, partly by means of its capsule and fibrous attachments, and partly by the apposition of the neighboring viscera and the tone of the abdominal wall. In the center of the concave medial border of the kidney is the hilum. This is a deep, longitudinal fissure which receives the renal vessels, nerves, and lymphatics, and from which the ureter emerges to pass downward to the bladder. Usually the vein is in front, the artery in the middle, and the ureter behind. The deep portion of the hilum expands into the renal sinus. This contains the upper portion of the renal pelvis, the calyces, and the branches of the renal vessels and nerves. The pelvis with its calyces is really the expanded upper portion of the ureter which lines the sinus renalis and embryologically is related to the ureter rather than the kidney. This explains why certain abnormalities, such as reduplication of the pelvis and ureters, occur when the kidneys are normal in every other respect.

The kidney proper is composed of an inner medullary zone and an irregular outer cortex. The medulla, which is sharply differentiated from the cortex, consists of a series of striated, conical masses. These are called the renal pyramids, the bases of which lie peripherally in the cortex while their apices converge toward the renal sinus. The pyramids are composed of Henle's loops and the collecting tubules. The latter converge to form the papillary ducts which open on the papillae. The medullary rays are the papillary ducts and their collecting tubules. These are visible sub-divisions of the medulla. The cortex lies directly beneath the capsule and contains the glomeruli, most of the convoluted tubules, and a complex vascular network. It is reddish brown in color and soft and granular in consistency. The portions of the cortex that dip in between the pyramids are termed the renal columns.

The microscopic description of the kidney includes glomeruli, tubules, interstitial tissue, and arteries. Each glomerulus consists of a glomerular tuft, a capsule space, and Bowman's capsule lined by flattened epithelium. The glomerular tuft is made up of capillary loops, each of which has a basement lined by epithelium and covered by epithelium; the latter is continuous with the epithelium lining Bowman's capsule and with the tubular epithelium. Near the vascular pole of the glomerulus in relation to the afferent arteriole is found a collection of nerve cells called the juxtaglomerular apparatus. This is thought to be concerned with the regulation of blood flow through the glomerulus.

The chief function of the kidney is excretion. The cells of the tubules also form ammonia. Each kidney consists of 2,000,000 or more excretory units or nephrons. Each nephron is composed of three parts—an afferent arteriole, a glomerulus, and a renal tubule. These constituents are dependent upon one another for their health. A serious lesion of one constituent is apt to produce disuse atrophy of the others. Furthermore, the blood supply to the tubules passes through the glomerular capillaries first, so that an obstructive lesion either in the afferent arteriole or glomerulus will predispose to degenerative changes in the tubules. It is well understood that all of the major organs of the human body have a large reserve power. Owing to the large number of nephrons this is also true of the kidney. Under ordinary conditions only a small portion of the total number of excretory units are actively functioning at a given moment. The remainder are in a refractory state with little or no blood flowing through them. The controlling mechanism is a contraction of the afferent arteriole and most likely also the capillaries in the glomerular tuft. This explains why a great many glomeruli are spared when a toxin acts diffusely but temporarily on the kidney. This large reserve also explains why a large portion of the kidney may be destroyed without producing signs of renal insufficiency.

There are two phases in the secretion of urine — a physical filtration by the glomerulus and, secondly, the absorption by the tubule. It is known that the glomerular filtrate contains sugar, but under normal conditions it is absent in the bladder urine. We must, therefore, assume that the sugar was re-absorbed by the epithelium of the convoluted tubules. The very essential feature of the kidney is the renal filter, which allows the passage of urea glucose and sodium chloride from the blood into the glomerular space, but does not permit the passage of large size albumin molecules. At birth we have a full complement of nephrons, but immature glomeruli and tubules. The child is well into the second year of life before mature nephrons are in evidence.

The tubules are responsible for the concentration of the urine. If there were no tubules the daily output of urine would be 50 liters, or about two liters per hour. The earliest and most easily detected sign of renal failure is the loss of this ability to concentrate. At this stage we note that the specific gravity is low, that it does not vary greatly when liquids are restricted, and polyuria develops. Polyuria is a compensatory mechanism which allows a normal amount of solid to be excreted in a more dilute form. The loss of large amounts of renal cortex, no matter the cause, is compensated for by polyuria. It has been demonstrated that there is an important difference between compensated and decompensated renal hypofunction. As long as the hypofunction is compensated there is no accumulation of waste products in the blood, but when the loss of concentrating power can no longer be compensated by an increased output of urine there is a rise in the blood urea nitrogen and renal insufficiency has developed.

Perhaps we should return to the subject at hand and review the necessary laboratory data that will aid us in evaluating the patient with renal disease. The minimal acceptable pre-

surgical laboratory data should consist of a complete urinalysis, hematocrit, hemoglobin, blood sugar, and blood urea nitrogen. We refuse to administer an anesthetic for elective surgery until these routine laboratory determinations are available. The urinalysis must include qualitative examinations for protein, sugar, and acetone. In addition to these, we are interested in the color, specific gravity, pH, and a microscopic examination of the sediment. In 1827, Bright noted the presence of proteinurea. Although Bright was not the first to observe proteinurea, he was the first to correlate its appearance with renal disease. Of the various proteins that appear in the urine, serum albumin and serum globulin are the most important. These two proteins constitute the so-called "urinary albumin". They usually occur together, have almost the same significance, and both respond to all of the ordinary tests for "albumin". Proteinuria is the most important pathologic condition of the urine, and also the most frequent.

There are two types of proteinuria —accidental or false, and renal. The false proteinuria is due to admixture with the urine of albuminous fluids such as pus, blood, and vaginal discharge. The microscopic examination will usually reveal these artifacts. It occurs most frequently in pyelitis, cystitis, and chronic vaginitis, and the quantity of protein found is usually small. Renal proteinuria refers to protein which has passed from the blood into the urine through the glomeruli. Recent studies have shown that in some conditions, as in nephrosis, the urinary protein distribution closely resembles the proportions of normal serum proteins. In other conditions, as in renal calculi, the urinary protein distribution remains similar to that in normal individuals.

Renal proteinuria is either functional, sometimes referred to as physiological, and pathological. The physiologic proteinuria appears under conditions which must be regarded as abnormal. Among these are excessive muscular exertion, excessive ingestion of proteins, prolonged exposure to cold water, the late stages of pregnancy and childbirth. In these conditions the proteinuria is minimal, and transient protein is also frequently present in infants' urine — this is a function of the immature nephron. Perhaps another form of functional proteinuria should be included under this classification. Postural, orthostatic, or cyclic proteinuria appear at different times of the day and disappear with bed rest. In pathologic conditions and in most of the physiological conditions renal albuminuria may be due to one or more of the following causes:

1. Circulatory changes in the kidney, either anemia or congestion, as found in excessive exercise as a result of increased blood acidity, chronic heart disease, severe anemia, and pressure upon the renal veins in the late stages of pregnancy. Most of these causes, if continued, will lead to degenerative changes in the kidney and even to nephritis.

2. Irritation of the kidneys. Here there is damage to the glomeruli, or tubal cells. The amount of protein is usually small and the condition is transitory. This is the chief factor in toxic and febrile proteinuria. Among the anesthetic agents which fall into this category are ether, chloroform, and vinethene. In acute infectious diseases protein is found in the urine, due chiefly to the irritant effect of

bacterial toxins. This is quite common in diphtheria, scarlet fever, pneumonia, typhoid fever, and acute streptococcal infections. In any of these the renal condition may develop into true nephritis.

3. Organic changes in the kidney. These include the various inflammatory and degenerative changes commonly referred to as nephritis. In this category we must also include renal tumors and renal tuberculosis. The term nephritis includes glomerulonephritis, nephrosis, nephrosclerosis (the arteriosclerotic kidney) and chronic pyelonephritis. Glomerulonephritis is an inflammatory condition affecting primarily the glomeruli but with secondary damage to all parts of the nephron and the interstitial tissue of the kidney. Glomerulonephritis is largely a disease of childhood. About two-thirds of the cases occur in children under seven years of age. It should also be noted that this disease is uncommon under three years of age. This condition is interesting because it is caused by extra renal infection, most commonly a hemolytic-streptococcal infection in the upper respiratory tract. The term nephrosis is somewhat misleading as it is used in two different entities—toxic nephrosis and lipoid nephrosis. The toxic nephrosis is also known as tubular nephritis and is the response of the tubular epithelium to toxic irritants. These irritants may be exogenous as in heavy metal poison, and endogenous as seen in obstructive jaundice and in the toxemias of pregnancy. The pathology is found in the convoluted tubules. In the second type, lipoid nephrosis, the majority of the patients suffer from subacute glomerular nephritis, but they present a nephrotic rather than a nephritic picture. In this phase the pathology is limited to the tubules. Huge amounts of protein may be excreted in a 24 hour period in this condition and is commonly found to be as high as 15 grams. After a period of time this is replaced by classical nephritis. Nephrosclerosis is characterized by degenerative and fibrotic changes in the kidney. The arteriosclerosis causes ischemic atrophy of the glomeruli and tubules such as is seen in chronic glomerulonephritis. In pyelonephritis the inflammation extends into the kidney and destroys renal tissue. This is followed by fibrosis and contraction with various degrees of lowered kidney function.

The determination of the specific gravity of the urine is another of the important routine procedures which aids us in the evaluation of the patient with kidney disease. The normal specific gravity of the urine varies between 1.015 to 1.020. In pathological states it may vary from 1.001 to 1.060. In the fasting state, the normal kidney should dilute the urine to a specific gravity of 1.003 or less after the ingestion of 1500 cc. of water. It should also be able to concentrate the urine to about 1.030 when the patient is on a regular diet and water is restricted. The loss of these powers is evidence of defective renal function. The specific gravity is low in chronic glomerular nephritis, diabetes insipidus, and many functional mental disorders. It is found to be high in fever and subacute glomerulonephritis. The specific gravity of the urine is highest (over 1.030) in diabetes mellitus, and when this is associated with an increase in urine volume we should always suspect diabetes. It should be remembered that in any form of nephritis a sudden fall in specific gravity without a corresponding increase in quan-

tity of urine should suggest impending uremia. It is important to recall that a fixed specific gravity near 1.010 is an early sign of failing renal function.

The specific gravity and color vary together. Disproportion between color and specific gravity may be the clue that leads us to suspect renal disease. The color of the urine may be red from fresh blood as seen after rapid decompression in lower urinary obstruction, coffee brown in initial glomerular nephritis, or blood red after the administration of azo-gantrisin. This drug, incidentally, is the bane of our pathologists' existence. The urine of patients receiving this drug is totally unacceptable for routine analysis.

The normal pH of the urine is usually 6. Urine with a pH above 6.5 is considered to be alkaline, and that below 6 is considered acid. There is usually no significance to acid urine. Acidity is increased after the administration of certain drugs, by excessive protein ingestion, in acidosis, and whenever the urine is concentrated from any cause, as in hyperthermia. Alkaline urine, however, should suggest urinary infection. It should be noted that we administer sodium bicarbonate to make the urine alkaline in the treatment of transfusion reactions. If the urine is kept at a pH of 7.5 to 8, hemoglobin stays in solution, but if an acid pH of 4.6 to 5.4 is reached, the hemoglobin is precipitated in the renal tubules.

The chief urinary substances detectable by the microscope are red blood cells, white blood cells, pus cells, crystals, and casts. The casts are cylindrical bodies of precipitated protein and may be formed anywhere along the course of the nephron. The casts form most easily in alkaline urine and in the distal part of the nephron and the collecting system where the urine is most concentrated. Casts are not usually seen in advanced renal failure as the kidneys have lost their ability to concentrate urine. Blood casts are unique and found in glomerulitis. The most common cause of this condition is glomerular nephritis; however, blood casts may be found in emboli to the kidney, disseminated lupus erythematous, and Boecks sarcoid. They are less frequently found in renal ischemia and toxic nephrosis.

The urinalysis is important in the evaluation of patients because it tells us what the kidneys are excreting. Blood chemistry tests, however, are concerned with substances which the kidneys have retained or are unable to excrete. They, therefore, complement the investigation of the urine. The first blood test employed in urological work and the one which continues to be most helpful, and most widely used, is that for the determination of urea nitrogen. Van Slyke and his associates have demonstrated that in patients with chronic renal disease the renal function may be reduced to 40 per cent of normal before there is a rise in blood urea nitrogen above the normal maximum. Our laboratory expects the normal blood urea nitrogen to vary between 6 and 18 mg./100 cc. of blood. A few individuals normally run a blood urea nitrogen of 20 or more. This is due to excessive ingestion of protein. We should not assume this to be normal and should question the patient's cardiac and renal status. Any report above 30 is most definitely pathological, and anesthesia will be unsafe and must be deferred until proper treatment has been employed to reduce

nitrogen retention. At this point we must consider a few non-routine tests which will further aid us in the evaluation of the patient with renal disease.

It is well known that the quantity of urine excreted in 24 hours by a healthy adult is between 1,000 and 1,800 cc. Usually 40 to 60 per cent of the fluid intake is excreted by the kidneys. A graph of the daily intake and output is just as valuable an aid in helping to evaluate the patient with renal disease as it is in the patient with cardiac disease. The measurement of alkaline reserve can be accurately determined through the application of the carbon dioxide combining power. Carbon dioxide is the most important acid end product of metabolism. The large part of this is dissipated through the lungs. Another portion of the carbon dioxide is neutralized by ammonia formation and then built up into urea and excreted by the kidney. The kidneys exert a very special effort to maintain the body's supply of fixed bases. It is obvious that we must never permit respiratory acidosis to be superimposed upon the metabolic acidosis that is found with all serious forms of kidney disease.

We have long relied upon the Phenolsulfonphthalein (P.S.P.) and the urea clearance tests. Recently we have begun to appreciate the results obtained from two new tests. The one is a very simple test for the measurement of urine chloride, and the other the radio-renogram. The P.S.P. is an old, old test first devised by Rowntree in 1910. It consists of the intravenous injection of a red dye which is eliminated only by the kidneys. The time of its first appearance in the urine and the quantity eliminated within a definite period are taken as an additional measure of the functional capacity of the kidneys. The test is simple, harmless, and considered to be a most satisfactory functional test. Under normal conditions the dye first appears in the urine in five to ten minutes after the injection. Within the first hour after it appears, 40 to 60 per cent is eliminated, and in two hours 60 to 85 per cent. This test will sometimes reveal a serious degree of renal failure when other urinary findings are practically normal. The test is very valuable in diagnosis and prognosis in nephritis. The output is low in heart disease with decreased cardiac output. Low values are also noted in prostatic hypertrophy with urinary retention. This test should be repeated at regular intervals in order to plot improvement in kidney function.

The urea clearance test demonstrates that there is, under normal conditions, a direct ratio between the amount of urea in the blood and the rate at which the kidneys excrete urea. The onset of uremia bears a definite relation to blood urea clearance. It has been noted in all types of renal disease that whenever the clearance is decreased to 5 per cent of normal, uremia regularly supervenes. In glomerular nephritis and in early nephrosis, the destruction of the glomeruli can be demonstrated to be in proportion to the decrease in blood urea clearance. With a large amount of glomerular injury the kidneys are less able to rid themselves of urea.

The measurement of urine chloride is a simple, yet valuable, test of renal function. When oliguria is present following shock or trauma, it is at

times almost impossible to evaluate the patient's renal status. If pre-surgical treatment is to be successful, we must know whether the cause of the renal lesion is physiological, organic, or a combination of both. Standard clinical tests of renal function often yield similar results in either of these lesions, and, as previously noted, can yield false normals in the presence of marked kidney damage. The test proves to be a valuable aid in serious physiological problems, and can be correlated with the electrocardiographic findings in potassium depletion and in adrenal insufficiency. In these conditions, the urine chloride is high (60 - 120 mEq/liter) in proportion to the low serum chloride of about 80 mEq/liter. If the urine chloride is below 30 mEq/liter, we know that lower nephron nephrosis is not present and that our problem is one of fluid and electrolyte unbalance. During the oliguric phase of lower nephron nephrosis, the urine chloride is fixed at 30-40 mEq/liter. We consider the normal value to be about 95 mEq/liter. The quantity of chloride ions in the urine is a good measure of renal tubular function.

The recently introduced diagnostic renal function tests employing radioactive iodine (I-131) should prove to be of tremendous value to us in the evaluation of the patient with kidney disease. This test requires specialized equipment but where available the technique is quite simple. The radioactive iodine is injected intravenously. A recorder, similar to a geiger counter, is placed over each kidney. Thirty minute tracings are then simultaneously recorded on a kymograph. On the curves obtained the vascular segment is due to renal radioactivity and is represented by the initial rapid rise of the curve shortly after injection of I-131. The excretory segment is characterized by a gradual decline over the 30-minute period. Quantitative estimates of differential renal vascularity, tubular cell function, and the ability or inability of the kidneys to evacuate urine are determined from each renogram.

The function of the kidney is to maintain homeostasis of the body. This stability is maintained by repeated complete filtration of the entire blood volume. Renal function is altered during anesthesia, during complications associated with anesthesia and surgery, and during the postanesthetic period. Ether, vinethene, ethyl chloride, and chloroform manifest toxic effects upon normal kidneys and must not be used in the presence of kidney disease. The barbiturates decrease renal flow, perhaps due to a release of antidiuretic hormone, and this, when added to renal disease, frequently produces an unwanted, dangerously prolonged effect. Cyclopropane, when improperly administered, is associated with the production of respiratory acidosis. Serious decrease in blood pressure, no matter whether due to intentionally produced hypotensive anesthesia or to other mechanisms, causes various degrees of renal impairment.

In the presence of renal disease and decreased circulating blood volume, hypotension will most certainly increase our anesthetic mortality. In states of decreased blood volume, Levophed and other powerful vasopressors cause increase in renal vascular resistance and suppression of renal blood flow. This form of treat-

(Continued on page 373)

Ionizing Radiation and the Nurse Anesthetist

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The physician of today relies heavily on radiation techniques in carrying out numerous diagnostic and therapeutic procedures and the nurse anesthetist often finds herself playing an accessory role.

It is therefore imperative for every nurse anesthetist to understand the significance of radiation. She should have some knowledge concerning this field so that her life and the lives of her children will not be unnecessarily endangered. A particular awareness of certain factors is essential: What is radiation? How does it act? When is the nurse anesthetist most likely to contact it? What precautions should be observed? What safeguards can be employed?

Radiation is a form of energy that is transported from one place to another by the movement of particles or electromagnetic waves. This energy possesses a unique characteristic — the ability to remove electrons from atoms and molecules of matter causing an alteration in the chemical behavior of matter. This process is known as ionization.

Every human cell is composed of a nucleus, cytoplasm, and a cell membrane. The nucleus is endowed with the greatest responsibility for it governs all activities of the cell and contains the bearers of heredity, the genes. The cytoplasm and its inclusions perform many activities such as assimilation of food materials, growth, contraction, conduction of impulses, and cell respiration. The cell membrane controls materials which enter and leave the cell. Each of these parts is designed so that life's processes may be carried out harmoniously. Naturally, this can only be achieved when all cell components remain in a healthy undisturbed state. If such living cells are exposed to ionizing radiation, some interference of their normal pattern of behavior is almost inevitable.

Ionizing radiation does not affect all cells equally. Actively dividing cells such as sex cells, blood cells, hair follicle cells, epidermal cells, and the cells of a developing fetus are the most susceptible. Therefore conditions such as skin lesions, loss of hair, anemia, leukemia, and impaired fetal growth occur as a result of overexposure to ionizing radiation. If sex cells are exposed to radiation especially far-reaching effects are possible. In the nucleus of sex cells are the hereditary determiners, the genes, which control the characteristics of the next generation. If a particle of ionizing radiation strikes a gene, it is probable that it may alter its chemical configuration and therefore alter its potentiality. Such an altered gene is referred to as a mutant gene.

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Nearly 99 per cent of all mutations are detrimental or lethal. Detrimental mutations may reduce disease resistance or shorten life span, whereas lethal mutations are such drastic alterations that death results. Any increase in radiation exposure above the naturally occurring background radiation will therefore be dangerous.

Radiation in medicine is derived from two main sources: x-ray machines and radioactive isotopes. The diagnostic and therapeutic procedures using radiation are carried out either in the x-ray department or in surgery. The nurse anesthetist may come in contact with ionizing radiation from fluoroscopy, x-ray, and radioactive isotopes.

Fluoroscopy is widely used for aiding the physician in the removal of certain foreign bodies that may be lodged in the esophagus, trachea, or bronchus, or embedded in tissues of the body. Fluroscopic examinations also aid the orthopedic surgeon in viewing fractured bones during the closed reduction of fractures.

X-rays are employed extensively on major surgical procedures such as open reductions of the femur and hip pinnings. Sometimes the general surgeon may use x-rays in studying the structure and function of organs such as the gallbladder. He may also rely on x-rays to help determine the outline of certain blood vessels during vascular surgery. The urologist uses x-rays in studying diseases of the kidneys, ureters, and bladder. With the advent of modern heart surgery the cardiac surgeon has learned to depend on x-ray findings in the delicate technique of cardiac catheterization. The neurologist uses x-rays extensively for diagnostic procedures such as cerebral angiography, pneumo-encephalography, and ventriculography.

In recent years the use of radioactive isotopes has been extended into the field of surgery. Today it is not an uncommon technique to implant radon seeds in certain types of malignant tumors. Currently, radioactive gold is used in the treatment of certain types of intractable cancer. Among the more common types of drugs whose radioactive isotopes are used in medicine are: phosphorus, iodine, cobalt and strontium. Today radioactive isotopes are used in anesthesia in the field of research. They serve as tracers to determine the fate of anesthetic drugs.

The various means of exposure to radiation is essential information for every nurse anesthetist. A patient under anesthesia receiving radioactive isotopes, such as gold, is a source of radiation. Scattered radiation may also be received from the inside structure of radiographic or radiotherapy rooms, and from improper x-ray equipment such as faulty cones or filters. The nurse anesthetist may receive direct radiation from rays emitting around the screen, or from direct exposure while attending the patient. In fact anytime she stands in the path of the x-ray beam she is subject to direct radiation.

The precautions and safeguards that can be carried out depend primarily upon the individual nurse anesthetist. The first thing the anesthetist should do is to educate herself concerning ionizing radiation. She should obtain direct knowledge in this field by studying the works and results of scientists who have first hand information about this tremen-

dously important field of medicine. Since the nurse anesthetist is aware that physiological and genetical damages may result from overexposure to ionizing radiation, she should never remain unprotected in the room when x-ray exposures are being made. She should always wear a leaded apron and gloves while attending a patient who is receiving radiation. Sometimes the nurse anesthetist merely stands by for emergency service and in this case the x-ray control booth serves as a good barrier. Only when rendering service in the line of duty, such as is needed to maintain a patent airway, is the nurse anesthetist expected to be in contact with the patient. Even this should rarely be done, since she should never hesitate to intubate a patient, thereby affording a patent airway and making it possible to step away from the patient. The routine practice of holding a patient in position for x-ray should not be the duty of the anesthetist since the nurse anesthetist's contact with ionizing radiation is relatively high in comparison with most hospital workers.

The anesthetist should be aware of three factors concerning the hazards of radiation: distance, duration, and time of exposure. The greater the distance from the main source, the less the amount of radiation one will reecive. The longer the duration of exposure, the more dangerous may be the consequences. The chance of return to complete body normalcy is reduced the more frequently one is exposed. This is especially true in the return of blood to normal. It is to be remembered that radiation has a cumulative effect. As a safety precaution the nurse anesthetist should always wear a badge, such as a dental film, to check the amount of radiation to which she is exposed over a given period of time. A rotation system for those who administer anesthesia to patients receiving ionizing radiation should be set up in the anesthesia department and adhered to very closely. Anesthetists who are expectant mothers should automatically be taken from this list. A complete physical examination, including a blood count, by a qualified physician, should be given to every nurse anesthetist to rule out any deleterious radiation effects.

As an individual the nurse anesthetist should realize that she may be subject to radiation exposure derived from sources other than those in the hospital. These could be from the natural background, fallout, medical and dental examinations performed for her benefit, as well as miscellaneous sources with which she may come in contact.

Today science has revealed the drastic effects of ionizing radiation, and the medical profession is gradually assimilating these facts. The nurse anesthetist should find herself in accord with the rapidly expanding field of ionizing radiation and take heed of its tremendous potential to insure herself and future generations.

SUMMARY

1. All ionizing radiation in any amount is biologically deleterious.

There is no safe dose. 2. All persons, particularly nurse anesthetists, should be aware that the dangers of ionizing radiation are physiological and genetical in nature. 3. In view of these facts all nurse anesthetists should carry out the necessary precautions against ionizing radiation.

I wish to acknowledge with thanks the valuable suggestions and criticisms given me by Dr. Marion Kayhart, of the Biology Department of Cedar Crest College, who first impressed upon me the effects of ionizing radiation.

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New Drugs Related to Anesthesia

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I believe that in five years we will be practicing an entirely new type of anesthesia, with the major steps forward probably centered on intravenous and non-explosive agents. A hydrogenated hydrocarbon, such as methoxyflurane (Penthrane) which is non-explosive, non-flammable, stable and easily controlled, that may be used as an intravenous agent or in conventional vaporizers, might be considered as an example of this. Very likely we will see more and more cases done by electronarcosis as demonstrated recently by Hardy and Fabian of Jackson, Mississippi.

To point up the new thoughts in anesthesia, we have the interesting new Pauling theory to explain the mode of action of anesthetics. Dr. Linus Pauling, CIT Chemistry Professor and Nobel Prize Winner, has propounded the theory that anesthesia induces unconsciousness by causing the formation of submicroscopic crystals in the aqueous part of the brain tissue. Because crystals have less conductivity than liquids, the electrical activities of the brain are slowed down enough to cause unconsciousness and insensitivity to pain. Perhaps only 0.1% of the aqueous material need be converted into microcrystals to cause unconsciousness, since this alone would block electric oscillations in which electrically charged ions and side chains of proteins present in the aqueous part of the brain take part.

There is a striking parallelism between the concentration of the anesthetic gas required to form the hydrate crystals in the laboratory in the absence of brain tissue and the concentration required to produce anesthesia. Since these hydrate microcrystals form under different conditions, they have holes in the molecular structure of different sizes and will accommodate anesthetic molecules of different sizes. Therefore, mixtures of anesthetics produce better anesthesia than a single agent. Cooling the brain 10-15° F. causes hydrate crystals to form, acting to produce unconsciousness without an anesthetic. This theory explains why Xenon is an effective anesthetic agent. Since it does not form any ordinary chemical compound, the anesthetic action of this agent has been hard to understand. Xenon does, however, form a crystalline hydrate by joining 4 Xenon molecules to 23 water molecules in an open regular framework. The Xenon atoms stabilize the hydrate to higher temperatures than the hydrate of water alone could stand.

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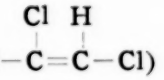
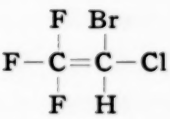
Dr. Pauling's concept also explains why divers become unconscious from nitrogen while breathing air under high pressures. The hydrate microcrystals formed by water and nitrogen is not very strong but it is adequate to stabilize hydrate microcrystals when the pressure of the nitrogen is high. Replacing nitrogen with helium checks the effect, because helium atoms do not stabilize formation of hydrate microcrystals.

History tells us that the earlier anesthetic techniques included suggestion, probably a form of hypnosis. This was to be considered a form of physical anesthesia. Chemical anesthesia started with the "spirits" or alcohol, followed in 1842 by sulfuric ether, and in 1844 by nitrous oxide. Time will prove whether or not we are on the threshold of a new age of physical anesthesia.

Some twenty-three ethers have been tried as anesthetic agents, but only two remain in use today: divinyl ether (Vinethene) and diethyl ether. In a large part, even these are well on the way out in larger centers. The search for non-explosive agents is driving us away from these as well as from cyclopropane and ethylene. Out of this search have come several agents:

1. Trilene 

Trilene was studied rather extensively in the United States by Jackson in 1935, and more extensively in England in 1939 by Hewer. It is not without its hazards and produces rather severe cardiac complications in higher concentrations. It is used in combination with Pentothal or other intravenous barbiturates and nitrous oxide for more major operative procedures. Its role in obstetrical analgesia with low concentrations has been good. It is still widely used in England, mainly because of its inexpensiveness.

2. Fluothane 

This agent, developed by the British, is known as Halothane in England and Canada. It is a fluorinated hydrocarbon that is nonexplosive and nonflammable. It produces deep planes of anesthesia with moderate safety to the patient. It is not without hazard and must be used by one familiar with close observation of the anesthetized patient at all times. It is compatible with nitrous oxide, barbiturates, narcotics and all relaxants. The bradycardia and hypotension produced by Fluothane are reflections on a deep anesthesia uncomplicated by adrenal stimulation. These effects can be reversed by lightening the anesthesia, or at times can be altered by adequate doses of atropine intravenously. It may be used with a non-rebreathing technique for complete anesthesia, semi-closed with equal parts of nitrous oxide and oxygen or with oxygen only, or, after complete knowledge of its capabilities, by a closed technique with physiologic amounts of oxygen only. It is still expensive, about 18 cents a cc., but only a small amount of the agent is required if it is used in a closed technique. It should be learned on a special, accurate vaporizer, but after proficiency in its usage has been acquired, any vaporizer will do. "You must learn to give it, it will kill if you let it give itself!"

3. Fluoether

A combination of 66% Fluothane and 34% ethyl ether will produce an azeotropic mixture having many of the properties of Fluothane, yet having a different boiling point than either of its parent agents. The azeotrope seems to produce fewer of the cardiovascular responses of Fluothane, but more nausea and vomiting in line with the effects of ether. This proportion of mixture gives a non-explosive agent which is less expensive than Fluothane. It is still more widely used in the special Fluothane vaporizer.

4. Penthrane

Methoxyflurane (difluroethylmethyl ether) is a competitor to Fluothane developed by Abbott Laboratories. It is non-explosive, non-inflammable, stable, and easily controlled. It seems to be very compatible with the cardiovascular system, gives complete anesthesia, and can be used with conventional vaporizers. This agent is compatible with all muscle relaxants, and can be used alone with barbiturates and nitrous oxide.

It has very recently been used in an emulsified form; administered by intravenous drip, producing anesthesia by a volatile agent. Satisfactory anesthesia was produced from 15-30 minutes in four patients at the University of Maryland by Dr. John Krantz, Jr. and his group. The emulsion of lecithin and Pluronic F 68, injected by continuous drip at the rate of 6 ml. per kg. per hour produces average anesthesia.

The emulsion can be sterilized without separating, requires only a small amount of the drug to induce rapid anesthesia, affects blood pressure only slightly, and is followed by rapid recovery with few side-effects. It remains stable for several months and is compatible with intravenous chemistry. Most present day intravenous anesthetics do not dissolve well in normal salt solution.

5. Fluoromar

Fluoromar is produced by The Ohio Chemical Company. It is competitive with other non-explosive ether compounds. It will burn, however, like an alcohol. The lower flammability limit, as determined by the U. S. Bureau of Mines, was found to be 3% as compared to ethyl vinyl ether, its non-fluorinated isomer, 2.1%, and diethyl ether, 1.9%. This, in review, is the energy required to ignite mixtures of anesthetic vapors and oxygen. It varies with the anesthetic and percentage of the anesthetic in an oxygen mixture. Dornette, of the University of Tennessee, has pointed out that this limit of flammability can be raised to 5-7% if a N_2O-O_2 mixture is used as diluent in a closed system where the water vapor is raised considerably. This work has not, to my knowledge, been substantiated by other investigators. But, if it be true, then the range of 3 to 8% necessary to produce anesthesia with Fluoromar would make it possible to conduct a relatively safe procedure even in an environment where static electricity could occur.

The use of N_2O slightly diminished the percentage of Fluoromar needed to produce anesthesia, and Pentothal induction fairly markedly reduced the amount needed in all planes. This merely confirms Pauling's theory of water hydrate crystals forming with various agents, and mixtures of anesthetics producing levels of anesthesia not predicted solely from drug synergism.

The induction period of this agent for producing unconsciousness is 1-2 minutes in infants and 2-4 minutes in adults, with surgical anesthesia levels comparable to ethyl ether of 10-25 minutes.

Fluoromar produces excellent analgesia very rapidly and has been used by some for burn dressings, obstetric analgesia, etc., through a cyprane vaporizer. Hypotension occurs without warning at times, appearing before the usual signs of deep anesthesia and occasionally while the patient is still moving. This responds rapidly to the removal of Fluoromar vapor and flushing it from the bag with oxygen. The heart seems to be protected against challenging doses of adrenalin by this agent.

At the present time it would appear to be useful in the presence of explosive hazards for procedures requiring only first or upper second plane anesthesia, such as dental, orthopedic, and certain types of gynecologic, urologic and general surgery.

6. Hexaflurodiethylether (Indoklon)

Indoklon is now coming into more and more usage as a pharmaco-convulsive agent by certain psychiatric groups. It is mentioned here to show the similarity between useful anesthetic agents and convulsive ones, and to mention the management from an anesthetic standpoint if called upon to handle this type of case.

Chemically, Indoklon is a colorless liquid, readily volatile with a pleasant odor. It is non-flammable. Clinically, the convulsions produced appear stronger than those produced by electric shock, but weaker than the seizures from intravenous Metrazol.

In most institutions, the following technique of Indoklon administration is being used on manic-depressive, schizophrenic, and psychoneurotic patients. The equipment used is made by the Air Reduction Company or the Trubeck Laboratories.

The patient is allowed to breathe into a rebreathing bag over a plastic and metal container holding 2 cc. of Indoklon after receiving Atropine Sulfate .2 mg., Pentothal 2½% from 10-16 ml., followed rapidly by succinylcholine 12-40 mg., depending upon the size of the individual. The seizure usually follows in about 40 seconds, and is mainly of a clonic nature lasting approximately one minute. Rarely does an apneic period occur as is so common with electric shock.

7. Agents being developed

To my knowledge, there are products being developed by DuPont and the Puritan Gas Corporation which are probably as good as, if not better, than any of these heretofore mentioned.

INTRAVENOUS AGENTS

The barbiturates have long been considered as anesthetic agents even though they produce their effect actually by acute poisoning of short, controlled duration.

1. Brevital Sodium (Methohexital Sodium, Lilly)

Brevital Sodium is the latest of the barbiturates to be introduced. It is a new oxygen barbiturate for intravenous anesthesia, which should be utilized as a drip as it is so rapidly metabolized. Its rapid effect and rapid breakdown makes it good for office procedures. When induction is rapid, muscle twitching may occur increasing to occasional convulsive movements from motor excitation. It may be considered of advantage in anesthesia for 1. reduction of fractures, 2. before convulsive therapy,

3. in genito-urologic and in gynecologic examinations, and, 4. in oral surgery.

Chemically, Brevital has no sulfur in its molecule. This is replaced by oxygen. There are two asymmetric carbon atoms which seem to cause marked potency. It is stable for about 6 weeks when dissolved in D/W at room temperature and from 4 to 7 days in other agents. The potency shows a marked drop after about 4 days. It is only slightly soluble in water, being a weak acid, and cannot be mixed with acid solutions such as atropine, curare, or succinylcholine.

Pharmacologically, Brevital is a potent, ultra short-acting intravenous drug, characterized by rapid smooth induction, producing satisfactory surgical anesthesia, and quick recovery. The total duration of a mean anesthetic dose rarely exceeds thirty minutes. Even on long procedures, there seems to be very little deposition in body tissues and even though larger total milligram doses of Brevital may be needed, compared to Surital or Pentothal, there is a much faster "wake-up" time. To produce anesthesia, only one-half the amount of plasma concentration of Brevital as compared to Pentothal is needed, indicating twice the potency. After 24 hours, no trace of Brevital could be found in the blood, whereas 35% of the amount present after a three hour Pentothal anesthesia was still present.

Intermittent administration of 1% solution or 0.2% slow drip infusions are favored. It takes from 50-220 mg. (5-20 cc. of 1% solution) to induce anesthesia. This will produce anesthesia lasting from 5 to 8 minutes. For maintenance, 2 to 4 cc. will be required every 4 to 7 minutes.

2. Sernyl (CI-395) 1(phenyl-cyclohexal) piperidine hydrochloride (Parke-Davis)

Sernyl, an intravenous agent, is still being investigated. It seems to produce a chemical hypnosis, with surgery, even laparotomies, being done on monkeys and even humans who are apparently awake but unconcerned about the operation. A drip form is used with only 0.2 mg./kg. of body weight necessary for anesthesia for an average operation. A dosage from 0.14 to 1 mg./kg. shows gradual slowing but no sleep pattern on the electroencephalogram. In the human, a very high degree of amnesia is present. There are little or no effects on the circulation except for a slight rise in blood pressure. No adjuncts are necessary although all of the relaxants are compatible. In overdose, the patients border on convulsions. This is probably an extrapyramidal type of reaction. It is doubtful that this product will become commercially available, but it does open the door to further investigation.

ADJUNCTS

A. Muscle Relaxants

The curare drugs, both natural and synthetic, have been used for about twenty years, and still have the advantage of having antagonists such as edrophonium and prostigmine, whereas, the very popular succinylcholine, a depolarizing drug, allows one to titrate the dosage to produce the required relaxation at will, when used in constant drip form. Little or no danger can come from succinylcholine, except for prolonged apnea following surgery.

The dosage of succinylcholine can be reduced quite markedly by using hexafluorenium bromide (Mylaxin-

Irwin, Neisler & Company). Mylaxin has a most unusual property in that it is a very efficient plasma cholinesterase inhibitor, but its activity is limited to the plasma; it does not, apparently, have access to intracellular cholinesterase. These properties form the basis of a simple technique for improving the performance of succinylcholine.

Since Mylaxin produces a mild but definite non-depolarizing block at the neuromuscular junction, it prevents the muscular fasciculation and twitching which may occur with succinylcholine and thereby decreases the degree and incidence of muscle pain after its usage. Mylaxin if used intermittently, the first dose after induction of anesthesia 1-2 cc. (20-40 mg.) and, after three minutes, 10-16 mg. of succinylcholine will produce apnea for about 30 minutes. Repeated intermittent doses of succinylcholine with occasional injections of Mylaxin will make a very favorable, relaxed environment for the surgeon.

This method of relaxation has the further advantage of not having prolonged irreversible curarization with long-acting relaxants. The accumulation of appreciable quantities of alkaline hydrolysis compounds seen with large doses of succinylcholine is thus avoided. Other new drugs in this category are also being developed.

B. Viadril

Viadril, which is a steroid, has been important as an hypnotic agent used intravenously in conjunction with nitrous oxide and other gaseous agents. Its use has been primarily as an induction agent. Because of venous irritation, it probably will not stand the test of time, but it leads to the possibility of other steroids as more profound and safe anesthetic agents.

C. Hormones

Study of the hormones quite possibly will open the door to important chemical anesthetic agents in the near future.

D. Antiemetics

Phenergan (long-acting) and Largon (short-acting) products of Wyeth Laboratories, are examples of phenothiazine derivatives that have contributed greatly to the relief of postoperative nausea or vomiting. Prolixin, a fluophenazine derivative produced by E. R. Squibb & Sons, has helped reduce nausea and vomiting from about 50% to 10%. It is given in a 1-1.25 mg. dose intramuscularly just prior to surgical termination and repeated 4 to 6 hours later. My present preference is Vistaril (hydroxyzine hydrochloride) a Pfizer product used in 25 mg. doses either intravenously or intramuscularly in a manner similar to Prolixin.

E. Local Anesthetics

1. Procaine

Soviet surgeons are using massive doses of a weak solution, 1/4% procaine, on much of the major surgery being done in Russia at the present time. The average dose may vary from 3-4 Gms. by infiltration. This may be a technique that we have been overlooking.

2. Nesacaine

This chloroprocaine is less toxic and quicker acting than Procaine, with very few allergic manifestations, and little "hangover" effect. Its duration of action is short. I like to use the drug on sensitive patients where a block is needed, and for short-term epidural and caudal blocks.

3. Carbocaine

Carbocaine is a long-acting local anesthetic with low toxicity, which has great penetrating power. I feel that it is ideal for nerve blocks of 1½

to 2½ hours duration, especially if adrenalin is contraindicated. It comes in 1% and 2% strengths and for epidural blocks, the 1% carbocaine in Ringer's Solution is available.

4. Pontocaine (Tetracaine)

Pontocaine can be used in .15% to .25% solution for long-acting nerve blocks of peripheral nerves. The .25% solution, if it has adrenalin chloride 1-200,000 added, will act for approximately 5 to 9 hours. It is used widely as a spinal anesthetic agent with distilled water to make a hypobaric preparation; 10% solution in glucose as a hyperbaric solution; or with Neosynephrine 1-3 mg. to prolong the effect to 4 to 5 hours and sometimes longer.

PHYSICAL ANESTHESIA

A. Hypnosis

Words have long been known to have a profound influence upon the human emotions and actions. It is with the proper verbalization and terminology that much can be accomplished, whether or not time hypnosis is desired by either the operator or the patient.

The choice of the word "injection", instead of "stick" in the arm or "spinal shot" is more appealing to the patient. The use of the term "contraction" instead of the term "labor pain" leads to the patient's cooperation. Being told, "you don't have to have pain with your contraction", is convincing to many patients. To tell a patient "grit your teeth" is to have all muscles tense and heighten awareness of the on-coming injection. Instead, have the patient relax and test for relaxation to be sure before doing anything which might cause pain. Simple distraction is oftentimes enough. Where simple relaxation ends and hypnosis begins, no one knows exactly. Develop your own key suggestions to a patient and you will be surprised at the results.

B. Electronarcosis

For several years a number of men in several countries have been working with anesthesia produced by electronic means. The French succeeded in producing partial obstetrical analgesia by placing electrodes on the abdomen and each hip. The Japanese, in studying sources of brain waves in relation to anesthesia in dogs, used 1,000 kilocycles but found no uniformity of response. This could have been due to the different species used. Some animals were relaxed, while others were convulsant. Now in Jackson, Mississippi, under the auspices of the U.S. Army, a group has succeeded in anesthetizing a human being with electricity. Hardy and Fabian anesthetized a 65-year-old woman for an abdominal exploration with a 700 cycle-30 volt, 50 milliamp signal, amplified and introduced through half dollar size electrodes attached to the temples. Less than 60 seconds was necessary to induce the anesthesia and recovery was equally quick. This cycle, voltage and milliamperage, seems to be optimal for humans.

If this is all true, then both general anesthesia with electrodes placed at the temples, or local or spinal anesthesia may be a complete reality *now*. For local anesthesia, a cuff may be placed around an extremity for specific areas of surgery. Spinal anesthesia may be accomplished at any level of the spine with the simple placing of electrode needles, in the soft tissues on either side of the spinal cord. The human body is known to be a low voltage electrode battery of 1.2 volts. We are about to learn how to turn it off and on through electron transfer in a magnetic field.

Obstetrical Anesthesia

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This paper consists of a discussion of certain aspects of obstetrical anesthesia. These aspects are: a brief history of obstetrical analgesia and anesthesia; a review of the physiological and psychological processes of the obstetrical patient, the needs in general and, more specifically, those needs that the anesthetist can fulfill; a discussion of the methods and agents used, with special emphasis on those best suited for the frequent obstetrical complications; the new trends, i.e., hypnosis and natural childbirth; and, finally, a paragraph on the role of the nurse anesthetist in obstetrics.

HISTORY

The history of obstetrical anesthesia, or, perhaps more accurately, the attempts toward obstetrical anesthesia and analgesia, is of course as old as the history of man. The first Biblical reference to obstetrics is to be found in the Book of Genesis. In this first book of the Old Testament, we learn that as part of the punishment for man's first fall, women would bring forth children "in sorrow and pain." This quotation has many interpretations. One is that from this time on all children would bear the mark of the first fall and would be subject to ignorance, error, pain, and death, and that these circumstances would cause the mother's "sorrow and pain." Later writers of the Old Testament, however, and in particular the psalmists, frequently refer to this "sorrow and pain" as a physical entity at the time of labor and delivery. At any rate this statement was frequently quoted to childbearing women — supposedly to afford them some type of philosophical comfort.

The first records having reference to the use of opiates and soporifics for the relief of the pain of childbirth are Chinese. We read in Greek mythology, probably written contemporaneously with these Chinese records, that from the Egyptian Polydamma, wife of Thor, Helen of Troy is said to have learned how to prepare herbal remedies that banished sorrow from the memory of childbearing women. Since we know that the Egyptian women used the Belladonna drugs to enlarge their pupils in an effort to make themselves more attractive, one wonders if this was not a type of drug we know as scopolamine, which is an amnesic frequently used in obstetrics today.

Referring to this period of obstetrical anesthesia, Sir James Simpson wrote: "The ancients appear also to have attempted to relieve the pain attendant upon parturition by anesthetizing agents, as we may learn from the various Greek writers. Such a practice is mentioned by Platus in

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his *Ophelion,* and I may also quote the following passage. Theocritus says, 'For then the daughter of Antigone, weighed down with the throes, called out for Lucina, the friend of women in travail, and she with kind favor stood by her, and in sooth poured down her whole limbs an insensibility to pain, and so a lively boy was born.' "[1]

In some early civilizations, it seems the prevailing idea was, the faster the labor, the better. The means used to hasten the labor, however, were rather unfortunate. For instance, the women in the Serang Islands were delivered while standing erect, bound to a tree, with their arms together above their heads. Women in Asiatic tribes had a practice of kneeling in labor with an assistant standing on their shoulders. From this position they would try to pull themselves into a standing position by grasping a pole. But one shudders to read that, unfortunately for the women, the most widespread means of hastening labor was the practice of jumping on the abdomen of the laboring woman.

More humane methods of aiding the woman in labor are recorded, however. In Samoa, the woman would kneel in labor and during each contraction a strong man of the tribe would sit behind her and press his heels into her short ribs. These natives were convinced that this pressure alleviated their pain, and it is interesting to note that the area they selected for pressure was the same on which Cleland, in 1926, found to be the pathway of uterine pain as it entered the cord at the eleventh and twelfth thoracic segments.[2]

During the so-called Dark Ages, of course, there was little or no attempt to relieve the pain of childbirth and, as there was a definite ban on the giving of help by members of the medical profession during labor and delivery, most of the ineffectual help given revolved around superstitions, amulets, and such. The historical novel, *Krinstin Lavransdatter* by Sigrid Undset, depicts a typical labor and delivery in the fourteenth century in Norway. Because of the author's authentic historical setting and descriptions, one could assume that this is, in fact, a very valid record. In this story the only positive aid for childbirth was a sleeping draught prepared from herbs which "deadened" the pain and acted as an amnesic. The birth was attended by many midwives, who held the prevalent belief that the patient should walk for as long a time as possible, should be in a hot, stifling room, should scream with each contraction (to lessen the tension) and, if these techniques failed, there was a specific superstitious practice for each specific case.[3]

We may assume that labor and delivery were conducted in a similar manner for at least the following three hundred years. A few new superstitions, charms, and methods of force were the unfortunate "contributions" toward obstetrical analgesia and anesthesia.

In the sixteenth century witch trials, an attempt at what is now known as mesmerism, or hypnotism, was recommended. The method was to hold a sword before the patient who was directed to look at it steadily. A method such as this may actually have been one of some advantage, although it would seem accidentally so, because the same records relate that another method in which the witches had great faith was to hang

the husband by his feet in the next room until the labor was completed.

In the seventeenth century, one of the first physicians to offer a prescription for relieving the pain of childbirth was an American physician by the name of Zerubbabel Endicott of Salem, Massachusetts. He wrote the following prescription: "For sharpe and difficult travel in women with child take a lock of vergin's haire on any part of ye head, of half the age of ye woman in travel. Cut it very smalle to fine powder then take 12 ant's eggs dried in an oven after ye bread is drawne or otherwise make them dry and make them to a powder with the haire, give this with a quarter of a pint of red cow's milk or for want of it, give it in strong ale."[4]

In the early nineteenth century, we find a good account of the progress of obstetrical anesthesia in a thesis written by a Peter Miller as a requirement toward his doctorate, entitled, "The Means of Lessening the Pains of Parturition."[5] He suggested the three following methods:

1. The use of nauseating emetics to distract the woman in labor. Thus, the spasmodic contractions of the diaphragm were used to propel and hasten delivery as described by the ancient medical maxim: "A sick labor is a rapid one."

2. Vigorous exercise and semistarvation to stimulate the development of living conditions similar to those of certain tribes of primitive peoples who had been reported as having rapid and almost painless labors.

3. Phlebotomy of 400-800 cc. of blood during labor as a means of relieving pelvic congestion and of producing relaxation of the perineum. An added advantage to this method, according to Dr. Miller, is that it reduces the blood loss after the delivery of the placenta.

Less than 50 years after Dr. Miller's thesis, Dr. James Simpson discovered the value of properly administered chloroform as an obstetric anesthetic; Queen Victoria made it acceptable and desirable for most women by using it herself for her seventh delivery; and after a final battle against religious prejudices and superstitions, the way was clear for progress toward modern obstetrical analgesia and anesthesia.[6 a, b]

The major complicating factor now was the difficulty of finding a brain-drugging agent powerful enough to narcotize the mother while not endangering the baby. A second factor impeding progress was the relatively late discovery of the nerve supply of the uterus.

PHYSIOLOGY OF PREGNANCY

To have an understanding — comprehensive and efficient — of obstetrical analgesia and anesthesia, one must have a working knowledge of the physiology of pregnancy, the mechanics of labor and delivery, and the psychological implications involved. The more important aspects of the physiology of pregnancy of which the anesthetist must be aware would seem to be:

1. There is a pseudoanemia and frequently a true anemia of pregnancy. The pseudoanemia is due to increase of blood volume during pregnancy. The blood volume increases but the number of red blood cells does not correspondingly increase; this results in fewer red blood cells per 100 cc. of blood, and, consequently, a lower hemoglobin reading, although actually the hemoglobin can

be at its normal value. The true anemia that frequently accompanies the normal pregnancy is due to inadequate diet, storage of iron by the fetus, and frequently a decrease in the free hydrochloric acid in the gastric juices.

2. The heart of the pregnant woman has more work to do. It has a greater volume of blood to move through the circulatory system. The normal heart can well tolerate this, but the even slightly abnormal heart may find the added strain difficult to handle. Mitral stenosis, which is a most common heart disease, is one of the more difficult cardiac problems of pregnancy.

3. The enlarged abdomen decreases the length of the thoracic cavity. Although there is at the same time a widening of the thoracic cavity which may compensate, the mother frequently experiences respiratory embarrassment. The mother's respirations must also supply the fetus with adequate oxygen. Therefore, the oxygen demand is greater than that of the non-pregnant woman and the supply may be diminished.

4. The pressures of the enlarged abdomen change the size of the spinal canal and frequently lordosis occurs because of the compensatory change.

5. Toxemias of pregnancy in some form occur in one out of every ten pregnant women. Labile blood pressure is one of the cardinal signs of toxemia. These pressures range from very high, causing convulsions, to the low, causing inadequate circulation.

Among the more important aspects of the mechanics of labor and delivery for the anesthetist to keep in mind are:

1. The cause of the onset of labor is unknown; therefore, the patient frequently, not being prepared, has just eaten and suffers the emotional turbulence of being unprepared.

2. Labor is divided into three stages. The first stage starts with the beginning of the dilation of the cervix until the cervix has completely dilated. The main characteristics of this first stage are the increasing frequency, duration and intensity of the contractions, the bag of waters may or may not rupture, and there will be some bloody show. The pain in this stage is primarily due to the dilation of the cervix and lower uterine segment and to a lesser extent from the contractions of the uterus. These impulses travel with the sensory pathways and enter the spinal cord at T_{11} and T_{12}. It is during the early part of this stage that the patient can most adequately be prepared for anesthesia by the proper medications, a tranquil environment, and a feeling of security—most necessary but frequently disregarded.

The second stage of labor begins with complete dilation of the cervix and ends with the delivery of the baby. The characteristics of this stage are strong, frequent contractions accompanied by the patient's desire to bear down, an increase of bloody show, a change in the patient's voice to a deeper pitch, and frequently apprehension and anxiety with a desire to grasp something such as side rails, handle bars, etc. The pain of this stage is produced primarily by the distention of the lower birth canal, vulva and perineum and to a lesser degree by the contractions of the uterus. This pain is conveyed by sensory pathways which are component parts of the pudendal nerves. These fibers enter the cord at $S_{2, 3, 4}$.

The third stage opens with a rest period of from five to ten minutes, the contractions resume, there is an

increase of bleeding, the cord lengthens, and the placenta is expelled. The pain in this stage is due to the distention of the cervix as the placenta is delivered and to the contractions of the uterus. The impulses enter the spinal cord at T_{11} and T_{12}, as in the first stage.

PSYCHOLOGY

The psychological implications involved in labor and delivery are complex and embrace the deepest emotional drives of every woman. They are, therefore, poorly understood although much has been written about them, and the common response is to ignore them. The anesthetist should recognize the fact that strong emotional energy is at a peak in the woman delivering a child and that this energy most often takes the form of fear and insecurity which may be expressed in such statements as, "I'm going to die"; "Am I doing everything the way you want me to do it?"; or, "I know something is wrong with my baby." Again, this energy may be redirected and expressed in a flippant, careless attitude or repressed by an unusually calm manner.[7] At any rate, to recognize that these needs are present and to treat the patient with reverence, respect, and competence will do much to fulfill the needs of this crucial time.

CHOICE OF ANESTHETIC

When considering the methods and agents used for obstetrical analgesia and anesthesia, it must be borne in mind as was mentioned before, that there has been great difficulty in finding an agent powerful enough to narcotize the mother without harming the baby. In the early part of this century, the well-defined techniques which were most popular, narcotized the mother well, in the majority of cases, but also produced a very depressed baby.

The first of these popular techniques, called the Gwathmey technique, was used predominantly around the year 1923. It consisted of magnesium sulfate 2 cc. in 25% strength, administered rectally every four hours, and morphine sulfate, gr. 1/4, when the patient's cervix was dilated to three centimeters. The magnesium sulfate could be repeated three times, if the labor lasted that long. As the second stage approached, ether, 75 cc., ethyl alcohol, 16 cc., and quinine, gr. 10, in 30 cc. of olive oil, were administered rectally. As magnesium sulfate is a central nervous system depressant and morphine is a respiratory depressant, it is obvious that such large doses produced a very depressed baby.

In 1935, the modified Gwathmey technique was introduced. During the first stage of labor, the patient was given Nembutal, gr. 6, by mouth and paraldehyde, 8 cc., rectally. The paraldehyde was repeated as necessary. During the second stage, the patient was given the same ether mixture as in the first technique. This technique produced excellent analgesia, good amnesia, a prolonged labor, and a depressed baby. In 1932, the paraldehyde was given orally, morphine sulfate, gr. 1/6, and scopolamine, gr. 1/200, were given by hypodermic injection. This technique produced almost complete amnesia, but again, the baby was very depressed as a rule.

The McCormick-Gwathmey technique consisted of a cleansing enema, establishing a good rapport with the patient, pentobarbital, gr. 3, p.r.n., and morphine sulfate, gr. 1/6. For the second stage, ether, 75 cc. in oil,

with 8 cc. of paraldehyde was given rectally. This technique, like the others, eventually had to be rejected because of the untoward effect of depression of the baby.

FIRST STAGE OF LABOR

Methods and agents for general analgesia and anesthesia in modern obstetrics are aimed at fulfilling three criteria.[8] They are:

1. The safety of the infant—particularly by adequate oxygenation at all times. This, of course, depends on the mother's respirations and circulatory adequacy judged by a normal blood pressure and hemoglobin.

2. The baby should not be depressed when delivered; he should be able to breath with little or no help.

3. The normal course of labor must not be interfered with.

Methods used for analgesia in the first stage of labor fulfill some of these criteria some of the time. The perfect method or combination of methods has not yet been produced, although the best agents used in the best way produce satisfactory analgesia.

Meperidine (Demerol) is one of the most often used drugs. The usual dosage is 50-100 mg., if given intramuscularly, or 12.5-25 mg., if given intravenously. It does depress the respiratory center and may cause nausea and vomiting, especially after the intravenous administration. The duration of effect is approximately two to four hours. It takes approximately 30 minutes after an intramuscular injection for full effect of the drug, and about 45 minutes for it to cross the placental barrier. Therefore, the timing of the administration must be cautious. The proper use of Demerol will make the labor less uncomfortable, relax the mother, and may hasten the labor.

Nisentil is an analgesic with a potency less than that of Demerol and with a duration of effect of approximately two hours. The dose range is 20-60 mg., if given intramuscularly, and 5-15 mg., if given intravenously. It has the same advantages and disadvantages as Demerol.

Morphine sulfate is the most effective analgesic. It is given in doses of 6-15 mg., intramuscularly, and 3-5 mg., intravenously. This is a good drug for resting the patient with uterine inertia, but it must be used with caution as it causes profound fetal depression.

The uses for the barbiturates in obstetrics are mainly to produce sleep and allay apprehension before active labor begins and to treat central nervous system excitation which may be caused by toxic manifestation of local anesthetic agents.

Of the ataractic drugs, Phenergan and Compazine seem to be the most used, although Sparine and Trilafon are considered very good also. The first three are given usually in 25 mg. dosage; Trilafon is given in a 5 mg. dose. These drugs do not relieve pain, but they relax the patient and relieve apprehension. Most of them are also antiemetics. Although these drugs have no ill effects in themselves, they potentiate the effect of other drugs given, so half of the usual dose of the analgesic is given. If this rule is not observed, hypotension and respiratory depression may occur.

The belladonnas, atropine and scopolamine, are used in conjunction with the analgesic. Atropine provides a drying effect and reduces vagal reflexes. Scopolamine has both of these effects plus the production of am-

nesia. Scopolamine frequently produces a disoriented patient. The dosages of these drugs is commonly 0.3-0.4 mg.

ANTAGONISTS

The narcotic antagonists, Nalorphine and Lorfan, are used in obstetrics to combat respiratory depression due to an overdose of a narcotic. The difficulty in balancing the doses prohibits the prophylactic use of these drugs in combination with the narcotic. It must be remembered that they will not help depressions caused by trauma, barbiturates or anesthetic overdosage, and that they may increase the barbiturate-caused depression. The doses for Nalorphine are 5-10 mg. for the mother, and 0.2 mg. for the baby, repeated p.r.n. The dose of Lorfan varies with the agent causing the depression. The route of administration is always intravenous, using the umbilical vein when being given to the baby.[9]

SECOND STAGE OF LABOR

As with methods and agents of analgesia and anesthesia in the first stage of labor, the methods and agents used in the second stage fulfill some of the listed criteria some of the time. The commonest cause of maternal mortality under anesthesia is aspiration of vomitus due to a general anesthetic. The commonest cause of fetal mortality is anoxia, which may have other causes but which, to a large degree, can be attributed to maternal analgesia and anesthesia.

Chloroform is a fast, pleasant, nonexplosive agent which provides good analgesia and relaxation. It can, however, pass through to the placenta and to the baby quickly and may damage the heart, liver, and kidneys of both mother and baby. Chloroform has been largely abandoned in this country, but is still used to a great extent in England and in Europe. It can not be used with soda lime. The most common method of use was to let a patient sniff at a gauze on which chloroform had been poured.

Divinyl ether, or Vinethene, causes a decrease in intrauterine pressure and a slowing down of uterine contractility; therefore, it is of choice when these conditions are beneficial. It is administered in combination with oxygen by means of a closed or semiclosed system, or by open-drop with a supply of oxygen under the mask. If the time of administration is prolonged, it can cause fetal depression and it also increases the possibility of postpartum hemorrhage due to the relaxed uterus. It should be used only for deliveries and procedures that are expected to be brief. If it is used for over thirty minutes, the heart, liver, and kidneys of the mother and of the baby may be damaged. If used in a concentration of 2% or less, analgesia is attained, 3.5% to 4.5% provides anesthesia, and 6% to 8% causes respiratory failure.

Ethyl ether is still considered good for obstetrical anesthesia because of its wide safety margin. It can be used alone with the open-drop method or in a machine with nitrous oxide and oxygen. For induction, 20% oxygen is required; for maintenance, 50% oxygen should be used. Six to fifteen minutes are required to achieve adequate relaxation for operative manipulations of the uterus. Ether provides good relaxation but definitely depresses the baby and frequently causes nausea and vomiting. The rather long induction and awakening periods and its flammability are added disadvantages.

Ethylene is used in various strengths to a maximum of 80% ethylene and 20% oxygen for a five-minute period for induction and then 50% ethylene and 50% oxygen. It has a very unpleasant odor, is explosive and flammable, gives little or no relaxation and frequently causes nausea and vomiting. It does, however, provide good analgesia and does not pass the placental barrier.

Nitrous oxide is never used to provide a total anesthetic in obstetrics as 85% to 90% is required and this percentage causes maternal hypoxia with severe lowering of the fetal oxygen saturation level. Mixtures exceeding 60% are contraindicated and analgesia is produced by inhalation of 20% to 40% only. This is useful for relieving pain during the latter part of the first stage. It is most useful if the interval between contractions is timed and this mixture is given to the patient so that the mother has a high blood level concentration of the mixture as the contraction starts. At the end of the contraction, this mixture is discontinued until shortly before the onset of the next contraction. These mixtures are frequently used as a supplement to local infiltration or pudendal blocks.

Nitrous oxide is used to a maximum of 80%, with oxygen at a minimum of 20%, for three to five minutes only; this is a 4:1 liter flow; for longer periods, 2 or 3:1 is used. It is recommended that the nitrous oxide be turned off after the delivery of the head and the breathing bag flushed with oxygen. Nitrous oxide is nonexplosive and nonflammable, and does not interefere with contractions. It, however, provides no relaxation, does pass the placental barrier and there is some depression of the baby.

"G.O.E." is a mixture of nitrous oxide, oxygen, and ether. "E.O.E." is a mixture of ethylene, oxygen, and ether. "G.O.E." is the most popular mixture of general anesthetics in use in hospital delivery rooms throughout the United States. The reasons for its popularity, according to Shane,[11] are:

"1. It is inexpensive and convenient to administer.
2. It is falsely believed to be nonexplosive.
3. Many delivery rooms are inadequately equipped and have machines through which only G.O.E. can be administered.
4. Obstetrical anesthesia is neglected, for the most part, by anesthesia departments, so what they have always used continues to be used."

The disadvantages of this method are (again according to Shane):

"1. It promotes maternal vomiting to a greater extent than any other anesthetic or combination of anesthetics — and aspiration of vomitus is the chief cause of maternal deaths.
2. It delays infant breathing and crying time.
3. It is explosive.
4. It is unsafe in inexperienced hands from the standpoint of aspiration.
5. It is highly unpredictable and must be varied for each patient."

The use of cyclopropane has special advantages in obstetrics. It is excellent whenever a rapid induction is required; or in the presence of hemorrhage and shock, its vasoconstrictor properties help to maintain the blood pressure. It is also helpful when full uterine relaxation is re-

quired. Although of itself it may not provide the relaxation, the patient will tolerate a high concentration of ether sooner if anesthesia has been induced to Stage III with cyclopropane. Another advantage is that the anesthetist is able to use a high concentration of oxygen because of the potency of cyclopropane. Only 3% to 5% is required for analgesia, 6% to 8% for unconsciousness, 20% to 25% for anesthesia, 35% to 40% produces respiratory failure.

Disadvantages of cyclopropane begin with its potency—there is a narrow margin of safety; it is explosive and costly; and if used for a prolonged time, there will be depression of the fetal respiratory center due to maternal hypoxia. Two of the more popular techniques for the administration of cyclopropane are those of Greenhill and Shane.

Greenhill recommends 20% cyclopropane until time for the episiotomy, 30% for the episiotomy, and 35% for the repair. The flows used for 20% are 300 cc. C_3H_6, 500 cc. O_2, and 700 cc. He per minute; for 30%, 700 cc. C_3H_6, 300 cc. O_2, and 1000 cc. He per minute; and for 35%, 500-700 cc. C_3H_6, 300 cc. O_2, and 1000 cc. He per minute. Helium allows a maximum of eight breaths of the 20% mixture before the birth, which gives an even plane 1 of anesthesia, effecting a minimal, if any, respiratory depression of the baby. The helium in the mixture it is said, makes the anesthetic nonexplosive and nonflammable.[12]

Shane's technique consists of adjusting the flows to C_3H_6, 400 cc.; N_2O, 1,000 cc.; O_2, 2,000 cc. The mask is strapped to the patient's face and the exhalation blow-off valve is fully opened. After breathing this mixture, the sedated patient will be ready for the episiotomy and delivery in two to three minutes. According to Shane, the patient may be maintained on this mixture without fear of descending deeper than plane 1 of Stage III, regardless of how long the procedure continues. As the fetal head is being delivered, the flow of C_3H_6 is terminated, the breathing bag is emptied and the flow of O_2 is increased to 15 liters until the cord is clamped. To re-anesthetize the patient for repair, the breathing bag is emptied of O_2 and refilled with N_2O and the flows are readjusted to their original settings. The patient is permitted to breathe this mixture until the repair is completed. At the termination of the procedure, the mask is removed and the patient's head is turned to one side in order to drain mucus and fluids. Most patients will respond within three to five minutes. During the 100% O_2 period, the patient does not waken sufficiently to become unmanageable, and the interval does insure a well oxygenated baby.

To have good results from this method, however, the patient must be sedated. If she has not had the usual hypodermic during labor, then she must be sedated intravenously. Demerol up to 50 mg. with or without scopolamine is the usual mixture given. Without sedation, the use of this technique may or may not put the patient to sleep, she may become very restless and even irrational and unmanageable.[13]

In a series of 1,131 deliveries where this method was employed, the breathing and crying time was immediate in 63% of the babies. This compares favorably with the 80% immediate breathing and crying time

for patients receiving terminal saddle, pudendal or caudal blocks. In this same series, vomiting under anesthesia occurred six times. The vomiting always occurred during the oxygenation period. The patient was awake enough at this time to lessen the danger of aspiration. There were no maternal deaths in this series. Twenty-eight infants died within the first 48 hours after delivery, but none of these deaths could be attributed to the anesthetic. Moreover, this series of anesthetics was administered by interns and residents in obstetrics who had no anesthesia training.[15]

Fluothane in experienced hands may be of some value in the field of obstetrical anesthesia. It has been used in a gas-oxygen-Fluothane mixture, but if the one administering it has had no considerable experience, it is very difficult to control the plane and stage of anesthesia. Its main advantage is that it is nonexplosive and nonflammable. Maternal hypotension, which is induced by Fluothane and increase in hemorrhage during delivery due to the intense relaxation of the uterus caused by Fluothane, are real disadvantages over and above the extremely narrow safety margin allowed by its use.[15]

Trilene is a gas which is most commonly self-administered, although it can be given by the open-drop method or in a machine without soda lime. It provides good analgesia, and is used most safely as an analgesic only. It must be avoided in patients with anemia, cardiac, or respiratory problems.

The ultra-shortacting barbiturates are hypnotics, not anesthetics nor analgesics. In experienced hands, a single dose of approximately 150 mg. of 2% to 2.5% solution may be used for rapid induction in vaginal deliveries. This technique can be dangerous. Recent studies show that it takes from five to six minutes before an appreciable amount of the drug crosses the placenta to the fetus and eleven minutes for equilibrium of fetal and maternal levels to be established. The only indications for these agents would be: a rapid spontaneous delivery, toxemia with impending convulsions and patients with central nervous system diseases such as epilepsy and other convulsive disorders. The doctor and the anesthetist must work in complete harmony for the success of this method.

A number 18 needle is put into an arm vein with tubing and syringe containing a 2.5% solution of Sodium Pentothal attached. Oxygen is given by mask. A test dose of 2 cc. is given during the preparation for delivery to observe for exaggerated responses. The patient must be reassured frequently that she will receive this anesthetic after her efforts have caused the progress required. Coincident with crowning, and on indications from the obstetrician, 6 cc. are given and after a 30-second wait, an additional 2-4 cc. are given. The total should not exceed 12 cc.

Regional analgesia is used frequently in obstetrics. If given properly and if the patient is well prepared, regional methods will produce excellent analgesia and relaxation and will have no direct effect on the baby. However, probably because of improper administration, the spinal technique ranks as the second commonest cause of obstetrical anesthetic deaths.

Direct infiltration into the perineum with Procaine 1% or 2%, is a method frequently used. The advantages of this method are: no mortal-

ity, no pulmonary complication, no local or general complications, and the technique is very simple. There are, however, two possible sources of trouble—the solution may be injected into a vein and idiosyncracies to Procaine do occur—but very rarely.

A pudendal block consists of the injection of Procaine, Xylocaine, Cyclaine, or Metycaine bilaterally near the ischial tuberosity to anesthetize the pudendal nerve. This controls most of the pain of the perineum. For complete anesthesia of the outlet, the ilio-inguinal, genito-femoral and ilio-hypogastric nerves also must be anesthetized.

Para-cervical blocks are accomplished by introducing a long needle through the vagina and infiltrating each side of the cervix with Xylocaine 1% with epinephrine. This is done any time during the first stage of labor and affords 90 - 100% relief of pain with nearly complete safety for the mother and baby. The only disadvantages are that additional anesthesia is required for the second and third stages, there is probably some danger of infection involved and the procedure is time - consuming. Para-sacral (pre-sacral) block is another method of accomplishing anesthesia and relaxation of the cervix. In this method the agent is introduced through the foramen of the sacrum.[16]

Saddle block, the lowest possible level of spinal block, was reported by Parmley and Adriani in 1946.[22] This accomplishes anesthesia of the sensory nerves from the uterus which enter the cord at $T_{10, 11,}$ and $_{12}$. As the motor nerves come off the cord at $T_{6, 7, 8, 9,}$ and $_{10}$, this method should provide complete pain relief with little or no effect on the progress of labor. The many complicating factors, such as the size of the spinal cord, the amount of fluid in the subarachnoid space, the pressure of the enlarged abdomen and the effect of the contractions, and the smaller dose of the agent for pregnant women, may make this a dangerous procedure in the hands of the inexperienced.

Continuous caudal anesthesia was introduced in obstetrics in 1942. Its effects, like those of spinals, correspond to its height. It accomplishes good analgesia if up to T_{10}, and it stops labor if above T_{10}. The agent is not injected into the spinal fluid; therefore this method is considered safer than the spinal technic. The amount of the agent is greater than that used for a spinal block and accidental intrathecal injection of the agent will cause grave complications, if not death.

The newer methods, or as some say "fads," of obstetrical analgesia and anesthesia are natural childbirth and hypnosis.[17] Natural or painless childbirth originated with Pavlov's work defining and demonstrating the conditioned reflex. His basic experiment consisted of giving a piece of meat to a dog while ringing a bell. He demonstrated that after this had been repeated many times, the dog's salivary glands and peristalsis of the digestive tract responded to the ringing of the same bell even if the meat was not present. He proved that these conditioned reflexes, or inappropriate physical response from a learned psychological association, occurred frequently in the human as well as in animals. Those of Pavlov's school believed that the pain of childbirth was not a true pain, but a conditioned reflex. They postulated that, as the normal eye performs its function, i.e., seeing,

without pain, so the normal uterus should perform its function, i.e., expulsion of the products of conception, without pain. They reasoned that the psychological association of labor and delivery with pain has been so well learned in our culture that the woman in labor feels a normal uterine contraction and she "misinterprets" this contraction as pain.[18]

In 1877, the theory was advanced that parasympathetic fibers were excitatory to the longitudinal muscles of the fundus and cervix and inhibitory to the circular fibers, while the sympathetic nerves had an opposite effect. Grantly Dick Read used this theory plus Pavlov's conditioned reflex theory to promote his own theory that fear plus tension equals pain during childbirth.[19] He proposed that with correct knowledge, emotional security, and the ability to relax, the mother would not experience pain during labor and delivery. Read's theory has had a high percentage of success where it was carried out in detail; however, there have been some psychiatric casualties when selectivity of candidates was ignored.

The only objection to hypnosis in obstetrics is that it is not practical. Approximately only one-third of the patients are good subjects, one-third are difficult to prepare, and the remaining one-third cannot be hypnotized.[20]

OBSTETRIC EMERGENCIES

Anesthesia for obstetrical emergencies is frequently required. Probably the most common potential emergency is the patient who has recently eaten. If circumstances arise where a general anesthetic is necessary, intubation should be done; if not feasible to do it while the patient is still awake, it should be done as quickly as possible after a rapid induction. The head of the table is lowered during induction so that if vomiting does occur, the material will pool in the nasopharynx. Good suctioning equipment must be on hand at all times.[21]

The second most common potential emergency is the patient with an acute respiratory infection. If the infection involves only the upper respiratory tract, the patient can be treated in the routine manner. If the infection involves the lower respiratory tract and the secretions are copious, general anesthesia is contraindicated. A regional anesthetic settling below T_{10} will decrease the postpartum possibility of atelectasis. Paracervical and pudendal blocks plus nitrous oxide analgesia is the method of choice, nitrous oxide being nonirritating to the mucous membrane. For the patient with a chronic respiratory infection such as tuberculosis, respiratory depressant analgesics and anesthetics are contraindicated. If they must be used, the patient should be taught to use deep breathing exercises during the postpartum period.

Hemorrhage from placenta previa occurs as an obstetric emergency. Two things must be taken into consideration: whether the previa is total, partial, or marginal and the maturity of the fetus. Positive diagnosis can be made only by vaginal examination, which may increase the hemorrhage. For this reason, it is always performed in the operating room with all members of the surgical team, including the anesthetist, prepared to do a cesarean section. If it is deemed possible that the patient may deliver vaginally, nitrous oxide analgesia and a pudendal block are of choice.

Ruptured uterus is a most urgent problem. It usually occurs while the patient is anesthetized and during intrauterine manipulation. It results in severe uterine hemorrhage and immediate severe shock. If ether is being used, it should be discontinued and cyclopropane used. An intravenous venipuncture with a No. 18 needle must be done immediately using any parenteral solution available, but blood should be given as soon as possible. If immediate abdominal incision is necessary, relaxants need not be used as the abdominal wall is distended from pregnancy. Vasopressor drugs should be withheld if possible until the site of hemorrhage is at least partially repaired to avoid increased hemorrhage. Intravenous hydrocortisone may be necessary.

In the obstetrical complication of uterine inertia, frequently the patient has been "rested" with an opiate and then the labor stimulated by the use of Pitocin. There is particular danger here of tetanic contractions. Ether must be on hand to relax the uterus and oxygen must be available to treat the fetal anoxia which results from this type of contraction.

With cephalo-pelvic disproportion, no anesthesia should be started until the presenting part is crowning and vaginal delivery is certain. Then pudendal block and nitrous oxide-oxygen are the choice.

For breech presentation, pudendal block with nitrous oxide and oxygen are the usual choice. Emergency surgery for fetal or maternal distress may be needed. Cyclopropane would then be used for its rapid induction. If conversion to a footling, or other procedures, with considerable intrauterine manipulation is necessary, ether is needed for uterine relaxation.

For a transverse presentation, oxygen is given throughout labor for fetal distress and deep ether anesthesia is used if versions are attempted.

When heart disease complicates labor and delivery, a continuous caudal block or spinal anesthetic are preferred. These will relieve the patient from emotional tension and fatigue from long hours of pain and may decrease the possibility of tachycardia. The patient will also be free from depression of the respiratory center with the resulting hypoxia.

The toxemias of pregnancy are divided into mild pre-eclampsia, severe pre-eclampsia and eclampsia. For mild pre-eclampsia, a pudendal block with nitrous oxide and oxygen is satisfactory. If a general anesthetic is necessary, cyclopropane with assisted respirations to prevent carbon dioxide retention and the resultant hypertension is used. In severe pre-eclampsia, magnesium sulfate may have been used. If deep general anesthesia or spinal anesthesia is then used, vasodepression frequently occurs. Therefore, oxygen and vasopressors must be ready for use. The eclamptic patient frequently has received both an anti-convulsant and a hypotensive drug. This must be considered when selecting an anesthetic. Continuous spinal or caudal block are the methods of choice. If general anesthesia is used, intravenous barbiturate with 100% oxygen or intermittent doses of cyclopropane with oxygen are used. Ether, Avertin, chloroform, Fluothane, ethyl chloride, and Vinethene are contra-indicated because of the possibility of further kidney and liver damage.

In multiple pregnancy, the second twin is endangered twice as much as the first born; infant mortality increases with each additional baby in

the same pregnancy. The mother is in increased danger of postpartum hemorrhage and frequently the prematurity problem is involved. Small doses of a systemic analgesic may be given during the first stage, and a pudendal block followed by nitrous oxide and oxygen is given during the second stage. If relaxation of the uterus is necessary for the delivery of the second twin, cyclopropane and ether are used. It must be remembered that when a general anesthetic is superimposed upon a systemic analgesic, respiratory depression of the infant is frequent—particularly if the infant is premature.

Except in certain conditions, the success of emergency obstetrical anesthesia is not dependent so much on techniques and drugs as on judgment and experience and the close cooperation of the obstetrician and the anesthetist. Proper psychologic control of a patient in an environment conducive to comfort and tranquillity with the proper safeguards are as important as the anesthetic agents and machines in the management of obstetrical anesthesia.

CONCLUSION

Certain aspects of obstetrical analgesia and anesthesia are discussed. Because it was necessary to limit the length of the paper, certain important aspects, such as cesarean section, the premature infant, and resuscitation of the newborn — were not included. A brief history of obstetrical analgesia and anesthesia was presented with the hope of making obvious the reasons for the lack of progress, as well as making apparent the need for continued progress.

To administer obstetrical anesthesia in a competent manner, the anesthetist must know at least the important and pertinent parts of the science of obstetrics. This will enable her to understand her patient better, and to understand her own role and how to fulfill it more completely. The methods and agents used most frequently, with special emphasis on those used for specific complications, were discussed. The need for the anesthetist to have a basic knowledge of all methods and agents was demonstrated, but the greater need for her to perfect one or two methods that she can use well was suggested. The role of the nurse anesthetist in obstetrics presents a challenge which is rarely accepted wholeheartedly. One wonders why.

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Insurance

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Legislation

Emanuel Hayt, LL.B., Counsel A.A.N.A.

Article In Medical Journal On Death Caused By Failure To Supply Oxygen Results In New Trial

The Court of Appeals found for plaintiff administrator in the amount of $50,000 against defendant hospital on plaintiff's charge that a hospital employee negligently allowed a 20-minute lapse in the supply of oxygen to his wife and thereby caused her death. This court reverses on the ground that the trial court admitted into evidence a medical journal containing an article on plaintiff's wife's case in which opinions were expressed as to the cause and possible prevention of death, with which article the wife's attending physician testified that he agreed.

At the trial there was a sharp conflict in the evidence. Piotrowski, decedent's husband and the administrator of her estate, was the principal witness for plaintiff as to the circumstances leading up to and immediately preceding the death. He testified that his wife was a young healthy woman; that, following the Caesarean section for the delivery of her third child (her two other children had been delivered in the same way), he arrived at the hospital shortly before three o'clock on the afternoon of August 7 and observed that oxygen was being administered to his wife from a tank. He was able to converse with her in a normal way. About ten o'clock that night, Dr. Corey, decedent's attending physician and the superintendent and president of the board of trustees of the hospital, and another physician visited Mrs. Piotrowski, and Dr. Corey advised the nurse on duty, Mrs. Groff, to change the oxygen tank later on. About one a.m. on August 8, Dr. Corey returned, checked Mrs. Piotrowski and left. Shortly thereafter Mrs. Groff advised Piotrowski that the oxygen tank should be changed. She experienced some difficulty with the removal, saying that she was a little "rusty", and accepted Piotrowski's offer of assistance. The tank, still containing oxygen, was disconnected, and Piotrowski accompanied Mrs. Groff to secure a fresh tank located down a hall, some distance away. The new tank was procured and Piotrowski wheeled it on a cart to his wife's room where he connected it and started the flow of oxygen. He noted that his wife's complexion was blue. Dr. Corey arrived soon afterwards, removed the tubes, carrying the oxygen, from Mrs. Piotrowski's nostrils and advised Piotrowski that his wife had passed away.

As a witness for defendant, Dr. Corey testified as to his medical training and experience, and that since 1949 he had probably performed some 150 to 200 Caesarean sections. He stated that in his studied opinion Mrs. Piotrowski died of a pulmonary embolism. However, he

admitted that an autopsy, which was not performed, would have been necessary to verify definitely such diagnosis. Dr. Corey testified further that to the best of his knowledge Mrs. Piotrowski was continuously supplied with oxygen up to the time of her death, and that her husband had never complained to him about any lack of oxygen being furnished her. On cross-examination, Dr. Corey's attention was called to the August 1958 issue of the Ohio State Medical Journal, published by the Ohio State Medical Association, where there appeared, beginning at page 1058 and under the heading, "Case No. 192," a short outline of Mrs. Piotrowski's case furnished by Dr. Price of the Corey Hospital staff, wherein the cause of death was listed as a pulmonary embolism. Following such outline, there were several comments by a committee of unidentified physicians and by an unidentified consultant specializing in thoracic and cardiovascular surgery. The committee, in its comments, deplored the lack of detailed information concerning the examination of the patient and the lack of other authentic information. Because it was assumed that the patient was in good health and condition prior to the operation, the committee concluded that the presence of an embolus as a cause of death was no more than conjectural. Under the circumstances, which included the information before the committee that the patient's first Caesarean section was complicated by postoperative bronchopneumonia, the committee questioned the choice of the anesthetic administered to the patient but, on the facts presented, voted the death a non-preventable "maternal" one. In the separate and distinct comments of the consultant he opined that "to blame pulmonary embolism as a cause of sudden death without postmortem examination is fraught with danger." Then he described other conditions which might be responsible for the death. Somewhat later on, in reference to case No. 192, the following appears attributable to the consultant:

"A history of bronchopneumonia following the initial section should weigh heavily in one's choice of anesthesia. Spinal anesthesia does not obviate pulmonary complications but does lessen their incidence. In addition, strenuous postoperative positive pressure breathing, forced laughing, aerosolization of antibiotics and the parenteral administration of antibiotics should have been given as a routine upon awakening rather than waiting until the patient became symptomatic. The value of endotracheal intubation for endobronchial suction as well as oxygenation should be kept in mind if general anesthesia is undertaken. The rapid onset of symptoms in this patient within 24 hours of delivery makes the diagnosis of pulmonary embolism doubtful. Aspiration pneumonia or bronchopneumonia would seem much more likely, and on this basis I believe the death was preventable by changes both in anesthetic techniques and in immediate postoperative care."

The court held to the rule that medical books or treatises are not admissible in evidence to prove the truth of statements therein, there being no certainty as to their validity and no oath to substantiate their allegations or opportunity to cross-examine the author. Judgment was reversed and remanded for a new trial.

(Pietrowski v. Corey Hospital, 12 CCH Neg. Cases 2d 697 - Ohio.)

Hospital Safety

Harriet L. Aberg, C.R.N.A.

We have been asked about the temperature of storage areas for compressed gas cylinders in the following question. "Our machine is left along a wall which has on the other side a small steam sterilizer. Is this desirable?"

The answer depends on the answer to another question, what is the temperature of the wall and the area of the anesthetic apparatus?

The Compressed Gas Association and each individual gas company have many safety rules. One such rule governs the safety device in each cylinder of high pressure gas. If the cylinder becomes too hot, it will spring a slow leak, not explode. In a sense this can be compared to the fusible link on automatic closing fire doors. When the temperature of the area protected by such doors rises to dangerous levels, this link fuses or melts and releases the tension on the balance weight and allows the door to close, thereby stopping the spread of heat, smoke and fire.

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Quoting from the Code for Use of Flammable Anesthetics, N.F.P.A. #56, item #2329, "Sources of heat in storage locations shall be protected or located so that cylinders of compressed gases shall not be heated to the activation point of integral safety devices. In no case shall the temperature of the cylinders exceed 125° F. Care must be exercised in handling cylinders that have been exposed to freezing temperature to prevent injury to the skin."

The THIRTY-FIFTH QUALIFYING EXAMINATION for membership in the American Association of Nurse Anesthetists will be conducted on May 12, 1962. The deadline for accepting completed applications including the transcripts is April 1. Notice of eligibility will be mailed about April 9.

Applications should be forwarded early enough to allow time to request transcripts and have them returned to the Executive Office before the deadline date.

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Abstracts

Sadove, M. S.; Schiffrin, M. J. and Ali, S. M.: A controlled study of codeine, dextro propoxyphene and Ro 4-1778/1. Am. J. M. Sc. 241: 103-108 (Jan.) 1961.

"Codeine is a useful analgesic, but it has at least four limitations. It is an addicting drug, the raw material necessary for its manufacture may not always be available to the Western World, there are many patients who experience undesirable side effects from its use, and it has limited value in severe visceral pain. . . . There still is a need for effective analgesics which are at least as potent as codeine and which are free of the limiting characteristics of the narcotics. It appears that a recently synthesized compound, Ro 4-1778/1, may meet these requirements. . . .

"In preliminary clinical trials we found that the analgesic effectiveness of Ro 4-1778/1 and of codeine, milligram for milligram, is of the same order if these drugs are given orally. The purpose of the present study was to expand our knowledge of the clinical characteristics of Ro 4-1778/1, especially in comparison with other agents. To accomplish this, we selected a group of patients from the post-surgical orthopedic wards who were hospitalized for some period of time and had a rather consistent requirement for oral analgesics of the potency of codeine. . . .

"A double blind, controlled study of analgesic drugs was made in 43 male patients. . . . Fifty oral doses each of the following were administered: Thirty-two and 65 mg. dextro propoxyphene hydrochloride, 30 and 60 mg. codeine sulphate, 30 and 60 mg. of an experimental analgesic, Ro 4-1778/1, and a placebo.

"All analgesics except 32 mg. dextro propoxyphene were significantly more effective than the placebo. Sixty-five milligrams of dextro propoxyphene, 60 mg. codeine, and 60 mg. Ro 4-1778/1, provided similar analgesic effects. Ten patients with chronic pain, who could not tolerate codeine, were given 60 mg. doses of Ro 4-1778/1 orally 2 to 6 times daily for 6 weeks to 4 months, with beneficial effects.

"Ro 4-1778/1 was given intravenously in doses of 10 to 40 mg. to 15 postoperative patients in the recovery room. Pain was obtunded for 45 to 60 minutes after doses of 30 to 40 mg. There was no evidence of central, respiratory, or circulatory depression."

Ngai, S. H.: Effects of morphine and meperidine on the central respiratory mechanisms in the cat; the action of levallorphan in antagonizing these effects. J. Pharmacol. & Exper. Therap. 131: 91-99 (Jan.) 1961.

"The effect of morphine in depressing respiration has been extensively studied in experimental animals and in man. . . . The present investigation was undertaken to re-examine the action of morphine and meperidine on the central and reflex respiratory mechanisms. Particular attention was devoted to the concept of organization of the central respiratory mechanisms. . . . The action of levallorphan

in reversing some of the effects of morphine and meperidine was also investigated. . . . Thirty-five cats . . . were used. . . .

"The effects of morphine and of meperidine on the respiratory movements and on the various components of the central respiratory mechanisms were studied in vagotomized, decerebrate cats. The antagonistic action of levallorphan was also examined. Morphine and meperidine depress the responsiveness of the medullary respiratory centers to electrical stimulation, but at the dose levels studied they did not seem to impair the recruiting mechanism. The pontile apneustic center is also depressed by these drugs.

"Morphine and meperidine appear to have a preponderantly depressant action on respiratory rhythmicity. The facilitatory function of the pontile pneumotaxic center and of the vagal afferents was reduced or abolished. The inhibitory vagal reflex was accentuated. Levallorphan, as an antagonist, has its main action in restoring the respiratory rhythmicity."

Aldridge, C. W., Jr., Nanzig, R. P. and Beaton, J. H.: Uterosacral block and the obstetrical anesthesia problem. Am. J. Obst. & Gynec. 81: 941-947 (May) 1961.

"Women should be encouraged to demand adequate, effective, and safe anesthesia. They should be taught to expect labor and delivery to be pleasant experience. Since there is no one anesthetic method ideal for all patients, obstetricians should be familiar with different techniques so that they can fit the anesthetic to the patient rather than the patient to the anesthetic. . . . In March, 1959, after learning of the work by Spanos and Steele, we began to use uterosacral

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Shemano, Irving, Wendel, Herbert and Ross, S. D.: A pharmacological comparison of phenazocine hydrobromide and morphine sulfate as narcotic analgesics. J. Pharmacol. & Exper. Therap. 132: 258-263 (May) 1961.

"One of the recent attempts to dissociate potent analgesic activity of narcotics and their untoward properties is phenazocine. . . . The pharmacological properties of phenazocine described in the present report, while characterizing the drug as a narcotic, demonstrate that some of the narcotic side effects do not necessarily run parallel to potent analgesic activity. . . .

"The pharmacological actions of phenazocine, a new potent narcotic analgesic, have been shown [in dogs] to be qualitatively similar to those of morphine. Phenazocine, like morphine, produces analgesia, tolerance, respiratory depression, hypotension, bradycardia, colon spasm, excitation and mydriasis in cats, possesses antiemetic properties and its effects are antagonized by N-allylnormophine. The results indicate, however, that phenazocine exhibits a greater separation than morphine between its analgesic activity on the one hand and its cardiovascular-respiratory depressant effects in anesthetized dogs on the other. The separation of analgesic activity of phenazocine from undesirable effects was also demonstrated by phenazocine's lack of emetic effects in dogs. The results of this study indicate that phenazocine is a promising agent for the treatment of pain."

Carabelle, R. W.: Chloral hydrate, a useful pediatric sedative. Am. J. Opth. 51: 834-835 (May) 1961.

"With dismaying frequency, the eye clinic and the practicing ophthalmologist face the challenge of contending with an infant or a very young child. The prospects of performing satisfactory ophthalmoscopy, measuring the ocular tension, removing sutures and, in young children, probing the lacrimonasal duct, are usually bleak. Based on previous experiences, these procedures suddenly loom harrowing and the latter two may be fraught with some danger. . . .

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"I have used this hypnotic agent for the past 18 months and have found it safe, inexpensive, well tolerated and very effective. In conjunction with the appropriate topical anesthetic, sedation with chloral hydrate has permitted the execution of the procedures already mentioned in nine out of every 10 infants."

Book Reviews

Calderwood's Orthopedic Nursing. By Carroll B. Larson, M.D., F.A.C.S., Professor of Orthopedic Surgery and Chairman of Department of Orthopedic Surgery, State University of Iowa and Marjorie Gould, R.N., B.S., M.S., Supervisor of Orthopedic Nursing, State University of Iowa. The C. V. Mosby Company, St. Louis, Mo. Cloth, 547 pages, illustrated, 5th ed., 1961. $6.50.

Not only for anesthetists who are working extensively with orthopedic surgeons, but for all anesthetists, there is useful information in this text. The problems of posture are often similar for bed patients and for the patient in the operating room. Many of the devices and technics of bedside nursing may be transferred to the anesthesia period. Special problems of the pre- and postoperative periods are included. References follow each chapter and questions for study are presented.

The Principles and Practice of Surgical Nursing. By D. F. Ellison Nash, F.R.C.S., Surgeon, St. Bartholomew's Hospital (London); Children's Hospital, Sydenham; Chailey Heritage Hospital; Dean, Lecturer in Surgery, Demonstrator of Operative Surgery, St. Bartholomew's Hospital Medical College; Examiner in Surgery, University of London. The Williams and Wilkins Co., Baltimore, exclusive U.S. agents. Cloth. 1,032 pages. 2nd ed., 1961. $7.00.

The second edition appears only six years after the first edition. As the authors have mentioned in the preface, although those years have shown a great change in the surgical approach to therapy, the basic nursing principles have not changed. Each of the categories of surgery is presented with paragraphs on pre-operative care, anesthesia and postoperative care. Anesthetists may find this useful in clinical instruction for specific types of surgical cases.

Basic Mathematics. By Norman H. Crow-Hurst, Engineering Consultant. Formerly: Senior Mathematics Lecturer, S. E. London Technical College and Beckenham Technical College, London, England. John F. Rider, Publisher, Inc., New York. Paper, 143 pages, 1961. $3.90.

This is a first in a series of four books being prepared with the object of helping "the millions of people whom school failed to give an effective and confident background in arithmetic and mathematics."

By the use of progression from the simple problems of counting, the author skillfully leads the reader through the stages of addition, subtraction, multiplication, division, fractions, decimals, percentages and graphs. And the reader will enjoy the trip.

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WANTED — Young Female Nurse Anesthetist for newly expanded and renovated 222 bed hospital 30 miles North of Boston. We presently employ 3 full time Nurse Anesthetists and 2 full time Physician Anesthesiologists. Salary according to training and experience. Mountain, beach and resort areas nearby. Contact Harold S. Wright, Jr., M.D., Chief of Anesthesia, Hale Hospital, Haverhill, Mass.

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NURSE ANESTHETIST, Male or Female, for hospital on Staten Island, N. Y., excellent conditions. Write: Box B-44, Journal American Association of Nurse Anesthetists, Prudential Plaza, Suite 3010, Chicago 1, Ill.

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WANTED: Nurse Anesthetist for 55 bed Florida Hospital, liberal Personnel Policies, salary open, please write or telephone collect: Belle Glade Memorial Hospital, Belle Glade, Fla.

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Benz

(Continued from page 333)

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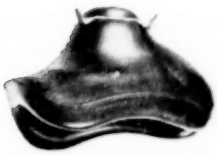

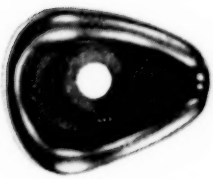

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